K.B.A.N.M.S. H.S.V.M. Library
B lore 42
Accession No: 206
U.D.C. No: 512+513(SUB)(N32
Date; 13.1.81

R.B.A.N.M'S H.S (M) LIBRARY
Bhore 42
Accession No ; 206.
U.D.C. No : 512+513 (SUB) N8
Date; 13-1-81

2207

2814

Acc 2/69/72

BANGALORE

PREFACE

TO

BOOK III

The publication of this third book of the series has been delayed from various causes ; Chief of them being the 'stir' created by the "questionaire" issued by the Director of Public Instruction. I had to wait and see, though practically the whole book was then ready for the press. Again my long and continued illness which confined me to bed for over three long months necessitated a further delay. I am quite aware of the keen disappointment I should have caused to many of my patrons who, I believe will with their usual sympathy accept the apologies of their convalascent brother. I take this opportunity to thank them for their long-suffering patience.

Special features of this book are :

(i) the beginning with Formal algebraic fundamentals to facilitate the generalisation of arithmetical practice ;

(ii) the collection, for purposes of revision, of choice and graded exercises on topics already detailed in Books I & II ; thus maintaining the compromise between the concentric and progressive systems ;

(iii) the directions given in the beginning of each exercise as to the stage of its suitability ;

and (iv) its suitability in all the three forms IV, V & VI.

For illustrations of principles explained, I have, as usual, selected the problems from the Public Examination papers.

My thanks are due to Mr. A. Natesan of the M. E. L. M. High School, Ambur, whose voluntary and gratuitous services in going through a few articles of my mss. and in the preparation of answers for a few Exercises somewhat belated, I could not however fully avail myself of.

The whole book has been gone through with the boys in the class-room itself and if still obscurities and errors are detected and communicated to me I shall gratefully acknowledge the contributions. I only pray for such constructive criticisms that it may be possible for me to improve the quality of this little treatise.

Pudukottai,
15th December 1932. } P. R. SUBRAHMANIAM.

R.B.A.N.M'S H.S (M) LIBRARY
B lore 42
Accession No: 206
U.D.C No: 512+513 (SU) N32
Date: 13.1.81

CONTENTS

Exercise		Page
I	Problems for Rapid Calculation employing artifices or short cuts ...	1—5
II-A	Algebraic Fundamentals : Numerical values ...	6 & 7
II-B	Algebraic Fundamentals: Numerical values ...	7
II-C	Easy Algebraic addition ...	8
II-D	Addition of algebraic expressions ...	8 & 9
II-E	Algebraic subtraction ...	9 & 10
II-F	Removal of brackets-Easy types ...	10
II-G	Do. do. slightly involved ...	11
	Principles of Algebraic Multiplication, Division and explanations of some algebraic terms ...	12—16
III-A	Algebraic multiplication by monomials ...	16
III-B	Algebraic multiplication by a binomial ...	17
III-C	Promiscuous examples on Algebraic Fundamentals ...	17, 18 & 19

Exercise		Page
III-D	Oral :—on algebraic monomial factors, easy algebraic fractions and their simplification, addition of algebraic fractions ...	19—21
IV A	Formal simple equations ...	21
IV-B	Problems on simple equations ...	23—26
IV-C	Do. equations simple and simultaneous ...	26—29
V-A	Symbolical Representation—oral questions ...	30 & 31
V-B	Symbolical representation—easy types for written work ...	31—35
V-C	Symbolical representation—more difficult types ...	35—37
V-D	Symbolical representation—slightly involved examples ...	38—41
V-E	Easy algebraic substitution ; List of mensuration formulæ ...	42—44
VI	Averages ...	45—47
VII-A	Percentages—Easy types ...	47—49
VII-B	Do. profit and loss, mixtures ...	50—54
VII-C	Percentages—Harder problems ...	54—60
VIII-A	Simple Interest ...	61—63
VIII-B	Compound Interest—Harder problems ...	64 & 65
IX	Proportion—Various types ...	66—68

Exercise		Page
	The Geometry of the Circle: Geometrical terms, properties of the sector, regular polygons with special reference to the Regular Hexagon, properties of chords, arcs, angles and tangents; select problems from the S. S. L. C. papers solved also for illustrations of principles detailed ...	69—83
X-A	On circles and their properties ...	83—86
X-B	Do. Harder types ...	87—89
XI	Exercise on the Theorem of Pythagoras ...	90 & 91
XII-A	Areas and volumes of prisms ...	91—94
XII-B	Do. do. harder ...	95—97
XII-C	Do. do. ; chiefly on cylinders ...	97—98
	The Geometry of the cone, its generation, curved surface, volume, etc., select questions from the S. S. L. C. papers solved ...	99—104
XIII-A	Exercises on cones—easy ...	105—106
XIII-B	Do. Harder ...	106—107
	Constants and Variables, concrete illustrations, algebraical relations, Theoretical and Graphical solutions of Problems ...	108—113

EXERCISE		PAGE
XIV-A	Elementary graphs: easy Problems and graphical solution of simultaneous equations ...	113—116
XIV-B	Problems depending on the form $y=mx+c$ ...	116—119
	Motion and velocity; effective rate, Graphical solution of more intricate problems, motion in a circle, motion of the hands of a clock. Trains and their lengths; crossing, etc. ...	120—126
XV	Problems on circular motion ...	126—127
	Miscellaneous examples ...	128
	Revision papers ...	
	S. S. L. C. Public Examination papers. 1911—32 ...	
	Answers ...	

EXERCISE I

N.B.—The principles of rapid calculation will be explained clearly.

Problems for Mental Work or Rapid Calculation

1. An equal number of half rupees, quarter rupees and two anna pieces together amount to Rs. 75-4-0. Find the number in each.

2. The monthly income of an officer is Rs. 250-0-0. In one year he saved Rs. 854-0-0. Next year he reduced his expenses by Rs. 18-0-0 per month. How much will he save in the next twelve months? How much will he have spent?

3. The sum of the ages of three men now is 72. Each one is three years older than the next younger? How old is the youngest? What will be the sum of their ages 10 years hence?

4. Silk was purchased at Rs. 4-13-0 a yard and sold at Rs. 5-1-0 a yard. The total gain made is Rs. 22-8-0. Find the number of yards purchased and sold.

5. If Re. 1 = 1s.-4d., how many rupees are equivalent to a £?

6. If the price of a book is quoted 10s.-6d. and if exchange is £ 1 = Rs. 13-5-4; what is its price in Indian money?

7. A *Kole* is 14 feet. How many *Koles* are there in $3\frac{1}{2}$ furlongs?

8. A cubit is supposed to be 18 inches. A man measures the length of a piece of cloth and finds it to be 18 cubits long but actually the length of his cubit = 17 inches. How much is this length short of 9 yds.?

9. If at 6 as. a yard, I buy cloth and measure the length with the forearm cubit, supposed to be 18 inches, but is really $16\frac{1}{2}$ inches, how much would I lose if I buy 8 cubits and pay the price of 4 yards.?

10. If 8 Km.=5 miles, what is the speed of a car that goes 24.2 Km. per hour ?

11. 1 dollar=4s.-2d. How much English money=761 dollars ?

12. 1 metre=39·37″. 1 தச்சு முழம்=34″. How many தச்சு முழம் are there in 20 metres, correct to the tenth of a தச்சு முழம்.

13. A cubic decimetre is a litre. How many litres are there in a cistern measuring 2·3 metres by 1·8 metres by $\frac{1}{2}$ metre.

14. Find the prime factors of 1485 and 2160 and hence find their H. C. F.

15. Find the smallest number above 87000 which contains 385 an exact number of times.

16. A length of wire weighs 25·6 grains (avoir). A roll of the same wire marked 5000 yards weighs 50lb. Find the length of the piece.

17. In a division sum the quotient is 187 and the dividend is 70,000. The divisor is the greatest possible. Find that divisor and the remainder.

18. A man takes 110 steps a minute each 30 inches long. How much is this in miles per hour ?

19. How many times can 0·013 be subtracted from 125·78 and what will be the remainder ?

20. Divide 126 into two parts such that one is $\frac{7}{11}$ of the other.

21. Two-thirds of the difference between a certain number and 40 is 28. Find the number.

22. I paid a certain number of men Re. 0-4-6 each and the same number of children Re. 0-2-0 each. Total amount spent was Rs. 19-8-0. How many were there ?

23. I had a five rupee note, seven rupees and 37 four anna coins. How many poor people can be given each Re. 0-2-6 ?

24. The telegraph posts on a railway are placed 58 yards apart and a passenger counts as he travels in the train, 37 in 2 minutes. Find the speed of the train.

25. A man owns $\frac{4}{5}$ of an estate. He sells 0·3 of his portion for Rs. 2,400. Find the value of the entire estate at this rate.

26. A coin is 1·2 inches across. If a hundred of these be placed so that each touches that next to it, what would be the length occupied? How many will be required to occupy a straight length of a mile?

27. A train runs without stopping a distance of 48 miles at 18 miles an hour. It reaches its destination just at noon. When did it start?

28. The children in a school can be formed into classes of 40, 36 or 45 with none over. Find the least number in the school.

29. A number lies between 1500 and 2000; but it is known to be divisible by 102 and 36. What is the number?

30. A number greater than 50 and less than 80 divides both 1728 and 1296 without remainder. Find the possible numbers.

31. By selling a book for Re. 0-3-9, 10% is loss. For how much must it be sold to gain 10%?

32. A man has £ 108-13-4. How many things each costing £ 5-4-2½ can he buy and how much money will remain over?

33. Find the compound interest on Rs. 75-0-0 for 2 years at 10%.

34. Find the amount at compound interest on £75-0-0 for two years at 12% for the first year and 15% for the second year.

35. Find the perimeter of a rectangular field which contains 4 acres and whose length is to its breadth as 5 : 2.

36. If a cubic inch of gold is beaten into a square sheeting 0·0025 of an inch thick, find the side of the square.

37. If the rate of interest be $6\frac{1}{4}\%$ per annum, find the amount at compound interest of Rs. 480-0-0 in two years.

38. If a bike purchased now deteriorates in value by $15\frac{5}{8}\%$ of its value at the beginning of a year, how much can be paid 2 years hence for one purchased now for Rs. 160-0-0.

39. One side of a right angled $\triangle$ is $0{\cdot}78''$ and the hypotenuse is $1{\cdot}3''$. Find the length of the other side.

40. The length of a rectangular park is 80 yards and its area is 4800 Sq. yards. How far is the fountain from a corner? The fountain is in the middle of the rectangular park.

41. If a ladder 16·9 feet long reaches a point 15·6 feet up a wall, how far away from the wall is the foot of the ladder?

42. An article is purchased for Rs. 16-10-8. It is sold at a loss of 64%. Find the selling price.

43. An agent is given 12% of the collections. If the owner gets a net income of Rs. 401-8-0, what was the total collection?

44. If by selling a bike for Rs. 100-6-0, a merchant loses 12%, what was the price he paid for it?

45. A dealer sells a bike for Rs. 200-12-0 and thereby gains 10%. What did he pay for it?

46. In a mixed school of boys and girls 25% are girls. Of the girls 45% pass, of the boys 55% pass. The number of boys passed is 198. Find the number of girls passed.

47. A saves 30% of his income. Another, B spends 67% of his income. Both save the same sum. If A spends Rs. 77-0-0, find their respective incomes.

48. Heat expands bodies; when heated a certain rod expands by ·05% of its length. If the length of the rod after heating is 4ft. 2·025 inches find its original length.

49. A couple of decades ago paper was selling at Re. 0-2-6 per lb. The current price of the same quality is Re. 0-5-6. Find the increase per cent.

50. An increase of 5% is sanctioned on pay drawn by officers and a cut of $3\frac{1}{8}$% on the increased salary immediately follows. By how much per cent has the pay actually increased ?

51. It is said that 240,000 letters are posted in Berlin daily, $16\frac{2}{3}$ % of which are town letters. This gives one letter for every three persons in Berlin. What is the population of Berlin ?

52. Ice is manufactured in a factory ; 30% of the stock is kept in the factory itself. The remainder is sent to branch shops. 4% of the ice kept in the factory and 12% of the ice sent to branch shops melt away. What per cent of the original stock is available for sale ?

53. What is the smallest number that will always leave 7 when divided by 8, 12, 15, 25 and 30 ?

54. What number multiplied by itself thrice will produce 66·430125 ? *i. e.*, If $x^3 = 66{\cdot}430125$, find x.

55. $\sqrt{2}$, $\sqrt{3}$ and $\sqrt{4}$—can these be the sides of a triangle ? What is the special property ?

56. Find the smallest number which should be multiplied with 6615 that the result may be a square.

57. How often can I subtract 539 from 7,440 ? What will be the last remainder ?

58. What is the smallest number which must be subtracted from 7,468 that the result may be divisible by 444 ?

59. Find the least number which must be subtracted from 64,281 that the remainder may be divisible by 96.

60. How much must be added to 1,742 that the remainder after division by 81 may contain 11 an exact number of times ?

61. The year x A. D contains $\frac{x}{8}$ days. What is the year ? Can it be 2920 ?

62. What is the average of all the odd numbers between 15 and 25 both included ?

63. A number is divisible by 99. Find the missing digits in 27*2 ?

EXERCISE II-A

Algebraic Fundamentals

Substitution of numerical values. To be done in Form IV and revised in Forms V and VI.

1. Given that $a=2$, $b=3$ find the values of :—

(i) $7a+b$
(ii) $3a+b$
(iii) $6a+2b$
(iv) $14a+8b$
(v) $10a+12b$
(vi) $b-a$
(vii) $3a-b$
(viii) $16a-24b$
(ix) $3b-4a$
(x) $12b-8a$
(xi) $7a+2b-a$
(xii) $6a-b+2a$
(xiii) $4a-2a+3b$
(xiv) $4a-3b+2a$
(xv) $14a-12b+12a$
(xvi) $16a-6-a$
(xvii) $16b-a+b$
(xviii) $14a-2b+3a$
(xix) $6b-a-8a$
(xx) $6b+a+5a-b$

2. If $a=2$, $b=3$ and $c=1$, find the numerical values of :—

(i) $2a+b-4c$
(ii) $2a+3b-a$
(iii) $a+b-5c$
(iv) $4a+2b-8c$
(v) $8c-b-a$
(vi) $8b-2c+a$
(vii) $8b+2c-a$
(viii) $2a-2b+c$
(ix) $12a-8b+3c$
(x) $14\cdot7a+3\cdot4b-8\cdot7c$
(xi) $1\frac{1}{2}c+3\frac{1}{3}b-13c$
(xii) $7\frac{1}{2}c+2\frac{1}{2}b-7\frac{1}{2}a$
(xiii) $1\cdot5a+2b+9c$.
(xiv) $9c-1\cdot5b+2\frac{1}{4}a$
(xv) $14a-8\cdot7b+1\cdot25c$

3. Given that $a=3$, $b=2$, $c=4$, $d=5$ find the numerical values of :—

(i) $2(a+b)+3(c+d)$
(ii) $2(3a+b)+4(2c+d)$
(iii) $7(3a+b)+4(2c+d)$
(iv) $8(a+b)+2c$
(v) $(4c+8b)+3(a+2c)$
(vi) $7(5d+6c)-2a+\frac{1}{2}b$
(vii) $8(a+6)+2(d-c)$
(viii) $7(d+a)+1\frac{1}{2}(c+b)$
(ix) $16(3a-2b)+1\frac{1}{2}(c+b)$
(x) $7(a+c)+3b+a$

4. Find the various numerical values of A from the formula $A=2h\,(l+b)$ given that

(i) $h=12,\ l=40,\ b=18$
(ii) $h=10,\ l=30,\ b=16$
(iii) $h=11,\ l=b=24$
(iv) $h=8,\ l=12,\ b=6$
(v) $h=18,\ l=60,\ b=24$
(vi) $l=3h=2b=48$
(vii) $l=3b$ and $h=\frac{1}{2}b,\ b=24$

5. From the relation $I=P\times R\times N\div 100$, find the values of I if :—

(i) $P=1400,\ R=8,\ N=4$
(ii) $P=1650,\ R=7,\ N=3$
(iii) $P=1750,\ R=12,\ N=2$
(iv) $P=4400,\ R=6,\ N=3$
(v) $P=500,\ R=18,\ N=2\frac{1}{2}$
(vi) $P=600,\ R=12,\ N=1\frac{1}{2}$
(vii) $P=750,\ R=18,\ N=3$
(viii) $P=1500,\ R=10\frac{1}{2},\ N=2\frac{1}{2}$
(ix) $P=1600,\ R=7\frac{1}{2},\ N=1\frac{1}{4}$
(x) $P=345,\ R=10\frac{1}{2},\ N=10\frac{1}{2}$

EXERCISE II-B

Algebraic Fundamental Operations

If $x=4,\ y=2,\ z=1$, find the value of :—

(1) $x+y+z$
(2) $x-y+z$
(3) $x-y-z$
(4) $3x-2y+z$
(5) $2x-y+2z$
(6) $9x-10y+4z$
(7) $19x-17y-6z$
(8) $17x-25y-13z$
(9) $x^2+y^2+z^2$
(10) x^2+xy+z^2
(11) y^2-yz+z^2
(12) y^3-y^2-y
(13) x^3-x^2-x
(14) x^3-1+x^2-1
(15) $x^3-z^3+y^3-z^3$
(16) $2x^2-3y^2-5z^2$
(17) $zy+xz+yz$
(18) $x+y+z-xy-xz+yz$
(19) x^2y
(20) xy^2
(21) x^2y+xy^2
(22) $x^2y+xy^2+y^2z+yz^2$
(23) $2x^2y+2zy^2+3xz-2yz$
(24) $3(x^2+y^2+z^2)-(xy+xz+yz)$

EXERCISE II-C

Add together,

(25) $4x, 5x, 2x$

(26) $7a, 2a, 5a$

(27) $4m, 2m, -m$

(28) $9a, -6a, -a$

(29) $-4a, 3a, a$

(30) $2ab, 3ab, -ab$

(31) $12xy, -4xy, -5xy, -3xy$

(32) $23pq, -11pq, -15pq, -7pq$

(33) $x-y, x+y,$

(34) $4x-y, 3x+y$

(35) $9x+2y, 4x+7y$

(36) $-6x+4y, 2x-5y$

(37) $2a+3b+5c, 3a-2b-c, 5a-4b$

(38) $3m+n-p, 2m-n+3p, -4m+2n+p$

(39) $3x-3y+z, 6x+3y-z, -4x-2y+3z$

(40) $15p-7q-7r, 15q-7r-7p, 15r-7p-7q$

EXERCISE II-D

Add together,

(i) $a^2-ab+b^2, 3a^2-3ab-7b^2, 4a^2-7ab+8b^2$

(ii) $7m^2+7m-6, 8m^2-8m+4, -11m^2-m+2$

(iii) $x^2+xy+yz, y^2+xz+xy, z^2-xy-xz-yz$

(iv) $3a^2+ab+bc, -2a^2-bc-ca, a^2-4ab-3bc+2ca$

(v) $17m^2+2n^2-5mn, 8n^2-5m^2+3mn, 4mn-5m^2-2n^2$

(vi) $2x^2+3xy-y^2, 5xy-x^2+3y^2, 2y^2-4xy+5x^2$

(vii) $7x^3-6x^2+5x-4, 5x^2-4x+5+x^3,$
$-4x^3-3x^2+2x-1$

(viii) $6p^2-5pq+3q^2, 3pq-q^2, -5p^2+2pq-3q^2$

(ix) $p^2+q^2+r^2, pq+pr+qr, -2p^2-3q^2+r^2, r^2-2pq,$
$-p^2-2rq, q^2-2pr$

(x) πr^2, $4\pi r^2$, $14\pi r$, $-7\pi r$

(xi) $3l^2+2lm-m^2$, $3m^2-lm+l^2$, $2l^2$, $-2l^2-m^2+lm$

(xii) $a^3+b^3+c^3$, $-2a^3-b^3+c^3$, $+2b^3-c^3-a^3$, $3a^3+2c^3-b^3$

(xiii) a^2-2ab, b^2-2bc, c^2-2ab, $a^2+b^2+c^2$, $ab+ac+bc$

(xiv) x^3z^2y, y^3-y^2z, z^3-z^2y, $x^3-y^3+z^3$, $y^3-z^3-x^3-z^3-y^3+x^3$

(xv) a^3-2a^2-3a-5, $2a^3+a^2-2a+6$, $-4a^3-6a^2+5a+11$, $11a^3+8a^2-a-1$

(xvi) x^3-xyz, y^3-xyz, z^3-xyz

EXERCISE II-E

1. Subtract :—

(i)	$5a$	from	$7a$
(ii)	$4a$	,,	$12a$
(iii)	$4p$	,,	$13p$
(iv)	$5a^2$	,,	$11a^2$
(v)	$5a^2+3b^2$	,,	$6a^2+7b^2$
(vi)	$3a^2+2ab+b^2$	,,	$5a^2+6ab+2b^2$
(vii)	$6m^2+2mn+5n^2$	,,	$7m^2+3mn+6n^2$
(viii)	x^2-xy+y^2	,,	$3x^2+2xy+5y^2$
(ix)	$3x^2-3xy+7y^2$	,,	$3x^2+3xy+7y^2$
(x)	$4a^2-7ab+8b^2$	,,	$6a^2+6b^2$
(xi)	$7p^2+7p-6$	,,	$8p^2+8p-7$
(xii)	$a+b-c$	,,	$a-b+c$
(xiii)	$2a+3b-4c$	,,	$3a+6b-5c$
(xiv)	$3a^2+2ab+3b^2$	,,	$5a^2-6ab-7b^2$
(xv)	$3l^2+2lm-m^2$	,,	$2l^2-2lm+m^2$
(xvi)	a^3+2a^2-a+1	,,	$2a^3+3a^2-2a+1$
(xvii)	$p^2+2pq+q^2$	,,	$p^2-2pq+q^2$
(xviii)	a^3-2a^2+3a-5	,,	$2a^3+a^2-2a+6$
(xix)	$2a^3+a^2-2a-7$	,,	$5a^2+2a^2+3a-6$
(xx)	$x^2-xy-xz-yz$	,,	$x^2+xy+xz+yz$

2. Add together :—

$7x^2-2xy+3y^2+7x-6y+8$ and $3x^2+4xy+4y^2-6x+y+4$ and from the result subtract $9x^2+6y^2-6y+3$.

3. Subtract $3a^2+2ab+5b^2$ from $7a^2-6ab-4b^2$ and to the result add, $-3a^2+9ab+10b^2$

EXERCISE II-F

Simplify by removing brackets :—

(i) $3a+(2a+b)$

(ii) $4a+(2a-b)$

(iii) $6-(7-6)$

(iv) $(a+b)+(a-b)$

(v) $(a+b)-(a-b)$

(vi) $2a+(3b-2a)$

(vii) $2a-(3b-2a)$

(viii) $3p-(2q-2p)$

(ix) $5-\{4-(3-2)\}$

(x) $3m-(2m-n)$

(xi) $7m-(3m-2n)+(2m-n)$

(xii) $2x+(2y+3y)-4x$

(xiii) $6x-(2y+3y-x)$

(xiv) $p+\{q-2p-(3q+p)\}-q$

(xv) $4m+\{2n-(3m-2n+2m)-n\}$

(xvi) $3a+\{2b-(4c+5a-2b)-c\}+2a-b$

(xvii) $5x-\left[2y+3z+\{2x-(3y+z)-4x\}+y\right]$

(xviii) $5l-\left[3m+5n-\{2m+(3n-2l)+5m\}\right]$

EXERCISE II-G

Simplify :—

(i) $(3a+2b)+(a-b)$

(ii) $(3a+2b)-(a-b)$

(iii) $3a-\{3a-(3a-b)\}$

(iv) $x-y-\{x-y-(x-y)\}$

(v) $2a+3a+\{2a-\overline{3a-2a}\}$

(vi) $7-3-\{8-(7-4)\}$

(vii) $5x-y-\left[3x-2y+\{7x-y\}\right]$

(viii) $3m+n+\left[2m-\{3n+5n\}-(3m+n)\right]$

(ix) $7p-\left[5q+2p-\{3q-2p\}\right]$

(x) $m-\left[m-\{m-(m-\overline{m-n})\}\right]$

(xi) $3z+(2y-z)-\{3x-\overline{2y+z}\}$

(xii) $4l-\{3m+(2l-m)+2l-4m\}$

NOTES ON ALGEBRAIC FUNDAMENTALS

(i) Take the algebraic term $5a^2b$.

5 is called the *numerical co-efficient.*

2 „ „ the *power of a* or the exponent or the index.

The factors of $5a^2b$ are 5, a, a, b, for

5, a, a, b multiplied together give $5a^2b$.

(ii) Take two algebraic terms.

If their literal factors be the same and be of the same degree, they are said to be **like terms**

$3x^2y$ and $7x^2y$
$5a^2b^2$ and $3a^2b^2$ } are like terms.

$3x^2y$ and $3xy^2$ are not like terms.

(iii) The power of a letter denotes the number of times the letter must be multiplied by it. a^3 denotes that a must be multiplied by itself thrice

$$a \times a \times a = a^3$$

also a^2 denotes $a \times a = a^2$

Again a^5 „ $a \times a \times a \times a \times a = a^5$

Hence the index law:—*When like letters are multiplied add the powers.*

Also $3a^2b \times 5ab^2 = 15a^3b^3$.

The distinction between an algebraic factor and an algebraic term should be explained clearly.

Terms are connected by the signs + or −

Factors „ „ × or ÷

(iv) To divide the power of a letter by another power of the same letter, write the letter and for its power take the power of the numerator—the power of the denominator.

$$\frac{x^3}{x^2} = x^{3-2} = x^1 = x.$$

$$\frac{x^7}{x^2} = x^{7-2} = x^5$$

$$\frac{4x^6}{2x^3}=\frac{4}{2}x^{6-3}=\frac{4}{2}x^3=2x^3.$$

$$\frac{12a^3b^2}{3ab}=\frac{12}{3}\,a^{3-1}b^{2-1}=4a^2b.$$

$$\frac{b}{b}=b^{1-1}=b^0$$

but we know that $\frac{b}{b}=1$.

Hence $b^0=1$.

(v) The rule of signs must be adhered to in multiplication and division.

Put in the simplest form :—Like signs give $+$
Unlike „ „ $-$

(vi) If different letters are divided, indicate the division.

Divide x by a :—We have the fraction $\frac{x}{a}$, just as $\frac{2}{3}$ or $\frac{7}{11}$.

Divide $3x^2$ by $2ax$; $\frac{3x^2}{2ax}=\frac{3x^{2-1}}{2a}=\frac{3x}{2a}$.

(subtract powers of like letters)

What is a fraction ?

$\frac{11}{12}$ is a fraction we know.

$\frac{11}{12}$ shows that 11 is divided by 12.

Similarly $\frac{a}{b}$ shows that a is divided by b.

A fraction is indicated by division

We indicate addition of a & b by $a+b$ (Sum)
" Subtraction of b from a by $a-b$ (Difference)
" Multiplication of a & b by ab. (Product)
" Division of a by b by $\frac{a}{b}$. (Quotient)

Consider the following algebraic fractions

$$\frac{x}{y},\quad \frac{m}{n},\quad \frac{3m^2}{m},\quad \frac{4m^2}{n},\quad \frac{5m^2n}{10m},$$

Which of these can be simplified ?...Index law for division of like letters.

Note.—(i) The fraction, The numerator, Denominator—Explain terms.

(ii) A fraction is not altered in value by multiplying both the numerator and the denominator by the same factor—compare with arithmetical fraction.

(iii) The common factors of the numerator and denominator may be struck off.

This is the converse of (ii).

(i) Add together $\frac{x}{a}, \frac{b}{a}, \frac{2x}{a}, \frac{3x}{a}, \frac{4b}{a}$

The denominators of the fractions are the same; what do we do in arithmetic? Add the numerators and put down the common denominator.

i.e., $$\frac{x+b+2x+3x+4b}{a} = \frac{6x+5b}{a}$$

(ii) Just as :—

$$\frac{x}{a} + \frac{y}{a} + \frac{z}{a} = \frac{x+y+z}{a}$$

$$\frac{x+y+z}{a} = \frac{x}{a}+\frac{y}{a}+\frac{z}{a}$$

Also $$\frac{3a+a^2+a^3}{a} = \frac{3a}{a}+\frac{a^2}{a}+\frac{a^3}{a}$$

$$= 3+a+a^2$$

(iii) Add together,

$3, \frac{3}{a}, \frac{7}{a^2}$ Make each denominator $= a^2$. The value of a fraction is not altered by multiplying the numerator and the denominator by the same quantity.

$$\left.\begin{aligned} 3 &= \frac{3a^2}{a^2} \\ \frac{3}{a} &= \frac{3a}{a^2} \\ \frac{7}{a^2} &= \frac{7}{a^2} \end{aligned}\right\} \text{Sum} = \frac{3a^2+3a+7}{a^2}$$

4. It will be so easy by judicious rapid questioning to revise the rules of monomial division,

(i) Divide x^2+x by x

$$\text{This is} = \frac{x^2+x}{x} = \frac{x^2}{x} + \frac{x}{x}$$
$$= x+1.$$

or $x^2+x = x(x+1)$.

The factors of the numerator are x and $x+1$.
The denominator is x
Striking off common factors we have $x+1$.

(ii) Similarly divide x^3+ax^2+bx by x.

$$\frac{x^3}{x} + \frac{ax^2}{x} + \frac{bx}{x}$$
$$= x^2+ax+b.$$

or
$$x \;)\; x^3+ax^2+bx \;(\; x^2+ax+b$$
$$\underline{x^3}$$
$$+ax^2$$
$$\underline{+ax^2}$$
$$+bx$$
$$\underline{+bx}$$

(iii) Divide $2x^2+5x+2$ by $x+2$

$$x+2 \;)\; 2x^2+5x+2 \;(\; 2x+1$$
$$\underline{2x^2+4x}$$
$$x+2$$
$$\underline{x+2}$$

Method. (i) Arrange the divisor and the dividend in descending powers of a letter common to both.

(ii) Divide the first term of the dividend by the first term of the divisor. This quotient is the first term of the quotient.

(iii) With the first term of the quotient multiply the whole divisor and subtract this partial product from the dividend.

(iv) Take the remainder. (This will also be in descending powers of the letter) Divide the first term of this new dividend by the first term of the divisor. This quotient will be the second term of the quotient.

(v) As before multiply each term of the divisor by this second term of the quotient and subtract this result from the new dividend.

(vi) The remainder may be treated as before *as far as possible.*

EXERCISE III-A

1. Multiply

(i) $3a$ by 5
(ii) $4p$ by 7
(iii) $4p+2$ by 6
(iv) $4p-2$ by 3
(v) $a+b$ by 2
(vi) $3a-2b$ by -4
(vii) $4a$ by $5a$
(viii) $4a$ by $2a$
(ix) $4a+2$ by $2a$
(x) $5a-2$ by $2a$
(xi) $a+b$ by 7
(xii) $a-b$ by 3
(xiii) $3a-2b$ by $2a$
(xiv) $3a-2b$ by $2b$
(xv) $3a-2b$ by -3
(xvi) $3a-2b$ by $-a$
(xvii) $5a+b$ by $-b$
(xviii) $7x+y$ by $2x$
(xix) $7y-x$ by $-x$
(xx) $7y-x+2$ by $-x$
(xxi) $2a+3b-4c$ by 7
(xxii) $5x+10y-100z$ by 2
(xxiii) $3m-2n$ by m
(xxiv) $3m-2n$ by $2m$
(xxv) $4p+5q-r$ by $2r$
(xxvi) $3a-2b+5c$ by $2a$
(xxvii) $a+b-c$ by $3a$
(xxviii) $7a-5b+c$ by $-2b$
(xxix) $7a^2+ab+b^2$ by 2
(xxx) $7a^2+2ab-3b^2$ by $2a$

EXERCISE III-B

(i) $3x+2y$ by $x+7$
(ii) $3x-2y$ by $x+7$
(iii) $3x-2y$ by $x-4$
(iv) $3x-7y$ by $2x-3$
(v) $13x+12$ by $7x-6$
(vi) $7x^2+x-5$ by $x+1$
(vii) $3a^3-2a^2+a-5$ by $a-2$
(viii) m^2-2m+1 by $m-1$
(ix) $4p^2+4p+1$ by $2p-1$
(x) $7k^3-3k+2$ by $k-4$
(xi) $4x^3-2x^2+x-5$ by $x-2$
(xii) $7x^2+2xy-y^2$ by $2x-y$
(xiii) $7a^2+2ab-b^2$ by $2a-b$
(xiv) $3x+2y$ by $3x+2y$
(xv) $3x-2y$ by $3x-2y$
(xvi) $4a-7b$ by $4a-7b$
(xvii) $4a+7b$ by $4a+7b$
(xviii) $12x^2-3y^2$ by $12x^2-3y^2$
(xix) $12x^2+3y^2$ by $12x^2+3y^2$
(xx) m^2+mn+l by $m+1$
(xxi) m^2-mn+1 by $m+1$
(xxii) a^2-ab+b^2 by $a+b$
(xxiii) $x^2-2xy+y^2$ by $x-y$
(xxiv) $a^2-b^2+c^2$ by $a-b$
(xxv) $pq+qr+rs$ by $p+q+r$
(xxvi) $7x^2+3x-1$ by x^2+x-1
(xxvii) $4x^3-x^2+3x-1$ by x^2+x-1
(xxviii) $7x^4-3x^3+2x^2+x-1$ by $x-5$
(xxix) $4m^2+n^2-p^2$ by $m+n-p$
(xxx) $a^2+b^2+c^2+ab+ac-bc$ by $a+b+c$.

EXERCISE III-C

Algebra—First four rules

1. If $x=7$, $y=3$ and $z=2$, find the numerical values of :—

(i) $3x-7y+z$
(ii) $2x-4y-z$
(iii) $x-2y+\frac{1}{2}z$
(iv) x^2y^2
(v) y^2-z^2
(vi) $x^2-y^2-z^2$
(vii) $3x^2-10y^2-8z^2$
(viii) $4x^2+12xy+9y^2$
(ix) $x^2+y^2+z^2+xy-xz-yz$
(x) $(x-y)^2+(y-z)^2+(z-x)^2$

(xi) $x^3+y^3+z^3-3xyz$

(xii) $\dfrac{x}{(x-y)(x-z)}+\dfrac{y}{(y-z)(z-x)}+\dfrac{z}{(z-y)(x-y)}$

2. Add together

(i) $a^2+ab,\ 3a^2-2ab,\ 3b^2-a^2,\ 2ab-b^2$

(ii) $x^2+4y^2,\ 2x^2-xy+y^2,\ 2y^2-2x^2,\ x^2+xy-y^2$

(iii) $a^2-ab,\ 3a^2+ab+b^2,\ 3ab-2b^2,\ b^2-ab$

(iv) $2m^2+n^2,\ 3mn-m^2,\ n^2-mn,\ m^2+m^2-2mn$

(v) $p^2+q^2+pq,\ p(q^2-p^2),\ q(q^2-pq)$

(vi) $3ab-2ac+3bc,\ 2ab-bc-ac,\ 3ac-ab+bc$

(vii) $\dfrac{3a}{4},\ \dfrac{5b}{2},\ \dfrac{2b}{3},\ \dfrac{7a}{2},\ \dfrac{8a}{3}$

(viii) $\dfrac{2x}{3},\ -\dfrac{x}{4},\ \dfrac{3x}{5},\ \dfrac{5x}{2},\ -\dfrac{x}{5}$

(ix) $\dfrac{3a}{8},\ \dfrac{2b}{3},\ -\dfrac{4a}{4},\ \dfrac{3a}{5},\ -\dfrac{b}{6}$

3. Subtract.

(i) $8p^2+7pq-q^2+3p-2q+9$ from $11p^2-6pq+2q^2-4+6q-6$

(ii) $3a^3+2b^3-c^3-8\,abc$ from $4a^3+3b^3-2c^3$

(iii) $2a^2-3b^2+8c^2-ab-ac-bc$ from $3a^2+4b^2+9c^2-3ab-2ac+2bc$

(iv) $3(x+y-z)+2(3x+y-2z)$ from $5(2x-y+z)-2(3x-y-2z)$

(v) $\dfrac{3a}{4}+\dfrac{2b}{5}-\dfrac{c}{6}$ from $\dfrac{a}{2}-\dfrac{3b}{5}+\dfrac{2c}{3}$

(vi) $\dfrac{a^2}{3}+\dfrac{b^2}{4}+\dfrac{c^2}{5}$ from $\dfrac{2a^2}{9}+\dfrac{3b^2}{8}-\dfrac{2c^2}{5}$

(vii) $\dfrac{3(x+10)}{4}-\dfrac{2(x+5)}{6}$ from $\dfrac{4(x-5)}{2}+\dfrac{3(x-6)}{5}$

4. Multiply

(i) $a^2+b^2+c^2-ab-ac-bc$ by $a+b+c$.

(ii) $a+b$ by $b+c$ and the product by $(c+a)$

(iii) $a-b$ by $b-c$ and the product by $c-a$.
(iv) $x-y$ by $y-z$ and the product by $z-x$.
(v) $a+b+c$ by $a+b-c$ and the product by the product of, $a-b+c$ and $b+c-a$
(vi) $x^2+y^2-z^2$ by $x^2+y^2+z^2$

5. In the product

(i) $(3x^3-2x^2+5x-3)(2x^2+5x-3)$: find the coefficient of x^3.
(ii) $(2x^2-5x+3)(2x^3-x^2+2)$,, ,, x^2.
(iii) $(x^4-x^3-x^2+x-2)(x^2+x-2)$,, ,, x^4,
(iv) $(7x^3-2x^2+x-2)(2x-7)$,, ,, z^3,

EXERCISE III-D

(Oral)

1. Give the elementary factors of :—

(i) $12a$
(ii) $12a^2b$
(iii) $18ab^3$
(iv) $9m^2n$
(v) $27mn^3$
(vi) $12a^2bc$
(vii) $49x^2yz$
(viii) $72xy^2$
(ix) $44x^2y^3$
(x) $77a^2bc$
(xi) $48m^2np$
(xii) $180\ pq^2$
(xiii) $74\ t^2r$
(xiv) $87m^2n$
(xv) $a^2b^2c^2$
(xvi) pa^2bc
(xvii) ax^2y^3
(xviii) pqm^2n
(xix) p^2q^2m
(xx) $48p^2q^2abc$

2. Simplify the following fractions by removing factors common to the numerator and the denominator.

(i) $\frac{72x^2y}{9x}$
(ii) $\frac{63m^2n^2}{7mn}$
(iii) $\frac{121a^2b^2c^2}{11abc}$
(iv) $\frac{3x^2y}{4ax}$
(v) $\frac{12x^2yz}{axy}$
(vi) $\frac{p^2qr}{pqr}$
(vii) $\frac{x^3y^2}{yz}$
(viii) $\frac{7x^2yz}{3axyz}$

(ix) $\frac{11a^2bc}{11a^2pq}$

(x) $\frac{121m^2n}{11amn}$

(xi) $\frac{48p^2q^3}{8r^2p^2}$

(xii) $\frac{256m^2nx}{192nm^2y}$

(xiii) $\frac{1800x^2a^2}{44y^2z^2}$

(xiv) $\frac{148p^3q^7x^2}{16p^2q^5x^2y}$

(xv) $\frac{98a^2b^2c^2}{49p^2a^2b}$

3. Find the sum of the following fractions by reducing them all to a common denominator :—

(i) $\frac{12}{x}, \frac{18}{2x}, \frac{40}{3x}$

(ii) $\frac{50}{p}, \frac{20}{2p}, \frac{a}{3p}$

(iii) $\frac{x}{a}, \frac{7x}{a}, \frac{5x}{4a}$

(iv) $\frac{a}{b}, \frac{3a}{b}, \frac{7a}{3b}, \frac{12a}{6b}$

(v) $a, \frac{a}{b}, \frac{3a}{b}, x$

(vi) $\frac{p}{q}, \frac{4p}{q}, \frac{11p}{3q}, \frac{2p}{5q}$

4. Split into separate terms :—

(i) $\frac{3x+2a}{5b}$

(ii) $\frac{4a^2+3b^2}{x}$

(iii) $\frac{3a^2+2b^2}{2a}$

(iv) $\frac{x^2+2xy+y^2}{xy}$

(v) $\frac{a^2-2ab+b^2}{ab}$

(vi) $\frac{m^2+3n^2}{2mn}$

(vii) $\frac{a^2+bc}{b^2}$

(viii) $\frac{4x^2+8y^2}{2xy^2}$

(ix) $\frac{7a+3a^2}{2a}$

(x) $\frac{33p^2q+11pq^2}{121pq}$

5. Reduce the following fractions to lowest terms, by striking off the factors common to the numerator and the denominator.

(i) $\frac{3}{3x}$,

(ii) $\frac{4}{4a}$

(iii) $\frac{3a}{4ax}$

(iv) $\frac{3a^2}{2ax}$

(v) $\frac{3a^2x}{2a^3x^2}$

(vi) $\frac{14a^2x^3}{7a^3x}$

(vii) $\frac{180a^2b^2c^2}{30abc}$ (viii) $\frac{77ap}{7a^2p^3}$

(ix) $\frac{pa^2b^2}{qabxy}$ (x) $\frac{m^2n^2t}{t^2n^2m}$

EXERCISE IV-A

Formal Simple Equations

1. Solve :—

(i) $(4x-3)-11=x-5$

(ii) $9(2x+1)-5(2x+1)=12$

(iii) $3(4x-2)+4(2x-1)+10=20$

(iv) $8(3x-1)-4(2x+5)=7x-1$

(v) $13(x-5)+18(3x-11)=2(15x-2)$

(vi) $(9x+5)-(6x-8)=x-9$

(vii) $7(3x-2)-4(x+5)=5x+2$

(viii) $4(x+3)-3(2x-1)=13x$

(ix) $x+3(x-1)=2(4x-3)-1$

(x) $7(3x-5)+2(x-5)+3(x-3)=24.$

(xi) $\cdot05(2x-4)-(5x-30)=-4\cdot5$

(xii) $2(x+11)-3(x-6)+\cdot12(x+11)=51$

2. Solve :—

(i) $\frac{3x-2}{7}-\frac{x}{3}=0$

(ii) $\frac{4x+10}{2}+x+2\frac{1}{2}=0$

(iii) $\frac{2x-5}{3}+\frac{x-4}{6}=\frac{2x}{7}+1\frac{1}{2}$

(iv) $\frac{5+2x}{10}-\frac{x+2}{7}=\frac{3x+7}{10}$

(v) $3(2x-5)-4\ (x-2\frac{1}{2})=x-1\frac{1}{2}$

(vi) $\frac{2x+16}{5}-\frac{13+x}{5}=\frac{x}{2}$

(vii) $\frac{3x-7}{5}-1=x-4$

(viii) $\frac{7x-2}{5}-(x+2)=\frac{2x-3}{3}-(x-3)$

(ix) $\frac{4x-5}{2}+(x-1)=2x-2$

(x) $\frac{3x+2}{7}-\frac{4x-3}{13}+\frac{2x+10}{6}=x$

(xi) $\frac{4x-3}{5}+\frac{2x-4}{10}=x-1$

(xii) $\frac{3x-6}{9}+\frac{x+3}{7}=\frac{x-1}{2}+(x-11)$

(xiii) $\frac{4x-5}{6}+\frac{2x-3}{3}+\frac{5x-1}{4}=\frac{3x-1}{4}+\frac{5x-6}{7}-\frac{x-5}{14}$

3. Five times a number increased by 2 is equal to four times the number increased by 5. Express this in the form of an equality and solve the equation.

4. I earn Rs. 20 more than my friend. I spend $\frac{4}{5}$ of my income but my friend saves $\frac{1}{4}$ of his income which is Re. 1 more than what I save. Find our incomes.

5. Four times a number increased by 8 is equal to the same number increased by 2 and multiplied by 4.

6. If to a certain number you add 8 and divide the total by 3 the quotient is equal to the original number diminished by 2.

EXERCISE IV-B

Simple Equations—Problems

To be done in Form IV.

1. Each of $15x+3$ boys subscribed four annas and each of 26 masters $3x+1$ annas and the total subscription was Rs. 28-4-0. How many boys did subscribe ?

2. By selling a house for Rs. 3,200-0-0, a man lost 3 times as much as he would gain if he sold it for Rs. 4,000-0-0. Find the cost of the house.

3. The height of a rectangular hall is 12 ft. and its length is $57\frac{1}{2}$ ft. The area of the four walls is 40 sq. ft. greater than the area of the floor. Find the breadth.

4. If a straight line stands on another straight line and each of the adjacent angles are represented in degrees by $2x+33$ and $x-3$, find the magnitude of each.

5. The rate per hour of a motor cyclist is 4 miles less than four times the rate of an ordinary cyclist. If the rate of the motor cyclist is 44 miles per hour, find the rate of the cyclist.

6. The number of men and women present at a cinema performance was as 5:2. If there had been nine more men the number of men would have been three times the number of women. How many of each were present ?

7. A meeting was attended by men and women in the ratio 7 : 5. 17 men and 25 women left it before the conclusion and there were at the close of the meeting twice as many men as women. How many of each were there at first ?

8. Find three consecutive odd numbers whose sum is 237.

9. A man's rate uphill is 2 miles an hour and downhill 5 miles an hour ; if he goes a certain distance and returns in 5 hours 15 minutes, find the distance.

10. I have a certain sum of money to divide equally between a certain number of poor people. If I pay Re. 0-5-6,

Re. 0-10-0 remain and if I pay Re. 0-5-9 each, only one anna remains. How many poor people were there and what was the amount I had ?

11. I travel a certain distance by car and on the return journey increase my speed so that the time taken is 36 minutes less than on the outward journey. If my original rate be 40 miles per hour and the distance 88 miles, find the increase in speed on the return journey.

12. A's income is 3 times B's income ; each of them saves Rs. 800 a year. A spends 5 times as much as B. How much does each spend ?

13. The denominator of a fraction is 19 more than the numerator. If 1 be subtracted from the denominator the fraction $=\frac{1}{2}$, find the fraction.

14. The numerator is 3 less than half the denominator. If 5 be added to the denominator the fraction $=\frac{1}{3}$, find the fraction.

15. A father's age is now 3 times that of his boy. 15 years hence he will be twice as aged as the same boy. Find their present ages.

16. To a certain number 14 is added and the result is divided by 12 ; from the same number 4 is subtracted and the remainder is divided by 10 ; the quotients are equal. Find the number.

17. I borrowed a certain sum from A, twice as much from B and agreed to pay them interest at 8 and $7\frac{1}{2}$ per cent respectively. If the total interest paid be Rs. 51-12-0, what is the amount borrowed ?

18. The combined ages of three brothers is 88. Twelve years ago the eldest was twice the youngest and 16 years ago the youngest was $\frac{2}{3}$ as aged as the middle one. Find their present ages.

19. The cost of burning an electric lamp is given by the formula $C/4 = \cdot 03ph$. where p is the candle power and h the number of hours the lamp burns and C is the number of annas.

Find (i) the cost of a 60 candle-power lamp burning 4 hours a day for 30 days.

(ii) the power of a lamp which burns 6 hours a day for 20 days, consumes 12 annas worth.

20. The shorter side of a rectangle is 15 inches and the longer is p inches. If the shorter were 36 inches longer and the longer 36 inches shorter, the area would be 4 sq. yards greater than now. Find the value of p.

21. A man cycling 8 miles an hour does a certain distance in the same time he will require if the distance were nine miles more and the rate 3 miles an hour faster. Find the distance. Frame an equation and solve it. Also suggest a shorter solution.

22. If I pay Re. 0-2-6 to each beggar woman I can give to 6 less than the number present; but if I give them at the rate of 2 as. each, I have enough to pay 14 more than the number present. How many were there?

23. Two men have together Rs. 180-0-0. One half the amount which one of them has exceeds $\frac{1}{7}$ of the other by 45. Find what each has.

24. In 5 years Rama will be half as old as Krishna was 10 years ago. Krishna now is 4 times as old as Rama. Find their present ages.

25. Two brothers are together 70 years of age. Ten years ago the age of one of them was $1\frac{1}{2}$ times the other's age. Find their ages?

26. A man is asked to work for 20 days. Each day he works he gets Re. 1-4-0. If he absents for a day, he must pay a fine of Re. 0-8-0. If at the end of 20 days he got only Rs. 15-0-0; for how many days was he absent?

27. A cow costs Rs. 8-0-0 more than a buffalo. If 2 cows and 3 buffaloes cost Rs. 326-0-0, find the price of a cow. Can you suggest a simple arithmetical solution?

28. Two numbers differ by 10. The greater divided by the smaller gives 2 for the quotient and a remainder 2. Find the two numbers.

29. In a certain number of two digits the digit in the tens' place is half the digit in the units' place and if 27 be added to the number the digits are reversed. Find the number.

30. In an estate three acres more than a third of the whole are let for paddy cultivation and four acres more than half the whole are let for plantain cultivation while the remaining five acres are reserved for sugarcane. Find the number of acres in the whole estate.

31. A man lending a certain sum at 12% gets Rs. 6-0-0 less than another who lends Rs. 90-0-0 more but at 10%. Find the sum.

32. A man lending a certain sum at 6% gets only Rs. 9-0-0 more than another lending Rs. 600-0-0 less but at $7\frac{1}{2}$%. Find the sums.

EXERCISE IV-C

Equations—Problems

May be done in Forms V & VI.

1. Two officers have the same annual income. The first saves 20 per cent. of his income, while the second spends Rs. 1,100-0-0 more than the other. At the end of three years, the second has incurred a debt of Rs 960-0-0. Find the annual income of each officer.

2. A merchant bought a bicycle for Rs 365-0-0, which he had to sell at a loss of 20 per cent. He bought another bicycle with Rs. 48-0-0 added to the proceeds. He sold this bicycle also and found that on the whole he gained Rs. 29-0-0. At what profit per cent on its cost did he sell the second bicycle?

3. An army 3000 yards from the enemy, advances 2600 yards in 21 minutes. The previous part of the advance, under artillery fire, was at 100 yards per minute, and the latter part under rifle fire was at 300 yards per minute. At what distance was the advancing army, when the other opened rifle fire?

4. A casuarina tope was auctioned by the sirkar and the highest bidder for Rs. 3,500 was ordered to cut down all the trees and remove them in 90 days, failing which he should pay a penalty of Rs 2-8-0 for every day beyond the 90 days. The bidder was idle for the first 55 days and then engaged 20 wood-cutters at Re. 1-4-0 each per day and 10 bandies at Re. 1-8-0 each per day. He realised a profit of Rs. 590 by selling all the wood for Rs. 6,000-0-0. Find the number of days for which he would have paid the penalty.

5. Four persons, A,B,C and D began a game of chance. A and B played and A won half of B's money; then B played C and the former won $\frac{1}{3}$ of C's. C and D played and C won a fourth of D's. They counted what each had and each was found to have 12 annas. With what sums did they begin the game?

6. A person owes certain sums of money to two creditors and finds that if he pays them respectively sums of money in the ratio 9 : 17, the sums unpaid will be 10% and 15% of the two debts and will together amount to Rs. 52. Find the amount of each debt.

7. The water in a certain reservoir is 6 ft. deep, but the level is sinking at the rate of 4 in. a day. The water in another reservoir is 3 ft. deep and is rising 5 in. a day. When will the depth of the two reservoirs be the same and what will this depth be? This question is to be solved by framing an equation.

8. A contractor promised to supply 800,000 bricks at Rs. 3-4-0. per thousand. He stocked a few thousands which had cost him Rs. 2-14-0 a thousand and had to buy the remainder at Rs. 3-14-0 a thousand, with the result that in the contract he lost Rs. 125. Find how many thousands he had stocked.

9. A carpenter has a certain number of chairs ready made and can make only a fixed number per week. He takes a contract for the supply of chairs and promises to supply regularly 45 chairs per week for 20 weeks or 47 chairs per week for 12 weeks. Find the stock ready on hand and the number he can make per week.

10. A gentleman was able to save in a certain year 35 per cent. of his income. Next year his income rose by $12\frac{1}{2}$ per cent. and his expenses also increased by 25 per cent. with the result that he saved Rs 36-0-0 less than in the previous year. What was his income in the former of the two years?

11. Two boys have together 37 marbles; one arranges a few of these in rows of five each, and another arranges the remainder in rows of three each. Altogether there are nine rows. How many rows are there in the arrangement of the former?

12. On a division in the House of Commons, if the number of members for the motion had increased by 50 from the opposition the motion would have been carried by 5 to 3; but if those against the motion had received 60 from the other party, the motion would have been lost by 4 to 3. Did the motion succeed, and how many members voted on the question?

13. At an election *A* received 250 votes more than *B*. An illegal proceeding was suspected and a re-election was therefore instituted. In the re-election 10 per cent of those that originally voted for *A* and 5 per cent of those that originally voted for *B* changed sides and *B* was elected by a majority of 100. Find the number of votes each secured originally.

14. A farmer borrowed Rs. 200-0-0 from a mirasdar on condition that for the use of the money the mirasdar should be given 35 measures of black gram and 20 bundles of straw. The farmer promised a few days prior to the due date, in full satisfaction, $61\frac{1}{4}$ measures of black gram and 10 bundles of straw; but on the day, he was able to give, also in full satisfaction, $45\frac{1}{2}$ measures of black gram and 54 measures of dhal. If, in any case, the mirasdar got $12\frac{1}{2}$ per cent interest, find at how many measures per rupee each of the cereals was rated. Also find the price of a bundle of straw.

15. Of two rival candidates *A* and *B* who stood for election, *B* secured 40 more votes than *A*; but on scrutinising 5 per cent of *A's* votes and 10 per cent of *B's* votes were rejected as illegal and *A* was therefore elected by a majority of 6.

Reduce the conditions to simultaneous equations in two unknowns and hence find the number of votes B secured originally.

16. Two launches race to a buoy and return. The first has a start of 10 minutes, steams at the rate of 6 miles per hour to the buoy and 8 miles per hour on the return. The second steams throughout at $7\frac{1}{2}$ miles per hour and is beaten by one minute. How long is the course?

17. (*a*) The sides x, y, z, of a triangle in inches are given by the relations $x-2y=3z=15$; $3y-2x=2z$. Find the lengths of the sides of the triangle.

(*b*) Find the magnitude of the greatest angle of the triangle and find the radius of the circumscribing circle of the triangle.

18. An attar merchant gave me specimens of two scented sticks of the same length one of which would burn for 4 hours and the other for 5 hours. I lighted them at once and after a time I found that what remained of one was exactly 4 times of what remained of the other. How long were they alight?

19. The value of $2x+3y$ is doubled when x and y are each increased by unity. Again the value of $2x+3y$ is halved when x and y are interchanged. Find the value of x and y.

20. (*a*) If a number be increased by 20 per cent of itself and if another number be diminished by 30 per cent of itself, the results are equal. Find the relation between the two numbers.

(*b*) If the sum of the two numbers be 380, find the two numbers geometrically by drawing to scale.

21. A certain quantity of goods is to be carried in carts and wagons and it is found that this can be exactly done with 24 carts and 8 wagons or with 15 carts and 12 wagons, but that 12 carts and 12 wagons will carry 2 tons less than the whole. What is the total quantity?

22. $ABCD$ is a rectangular enclosure. $AB=228$ yds. $BC=120$ yds. P is a point 90 yds. from A along AB. Find a point Q in BC such that the distance $PD+DQ$ is less than the diatance $PA+AD+DC+CQ$ by 136 yds. Also find the lengths of PD and DQ separately.

EXERCISE V-A

Symbolical Representation

May be done in Form IV.

1. (*a*) How many annas are there in Rs. 12−8 as?
   (*b*) ,, ,, ,, Rs. $a-b$ as.

2. If Rs. a plus $2a$ annas be equal to 54 annas, find a.

3. Find the number of shillings in £ $a+a/2$ s.

4. A man goes 24 miles at a certain rate. If the time taken be a hours and the rate x m.p.h., find a relation between x and a.

5. A man buys a viss of coffee at Rs. 2-4-0 a viss and a palams of sugar at 3 ps. per palam. Find the total cost.

6. The price per orange is a annas and that of an apple is $3a$ annas. Find the total cost of 4 oranges and three apples. If this total cost be 13 annas, find the cost of each.

7. (*a*) By selling an article for Rs. a, a man loses $\frac{a}{4}$ annas. Find the cost price.

   (*b*) If c be the cost price, frame an equation connecting c and a.

8. By selling an article for Rs. p, a man gains $\frac{1}{10}$ of what he gave for it. Find his cost price. If x be the cost price frame an equation connecting x and p.

9. (*a*) If x coconuts cost Rs. a., find the price of each in annas.

   (*b*) If $x=16$ and $a=1\frac{1}{4}$, find the price of each.

10. In a theatre a chair tickets at Rs. 2-8-0 each, $2a$ bench tickets at Re. 0-12-0 each and $10a$ floor tickets at 4 annas each were sold. Find the total collection in rupees. If the whole collection be Rs. 260, find the number in each.

11. Three consecutive numbers are a, b and c. Find $a+b+c$.

(i) in terms of a
(ii) „ „ b
(iii) „ „ c

12. Three consecutive odd numbers. are x, y and z. Find them.

(i) in terms of x
(ii) „ „ y
(iii) „ „ z

13. (a) A man is now x years of age. What was his age a years ago?

(b) What will be his age a years hence?

14. (a) The numerator is 3 less than the denominator. If the denominator is x what is the numerator.

(b) If 4 be added to the denominator, the fraction $=\frac{1}{2}$. Find the fraction.

EXERCISE V-B

Symbolical Representation

May be tried in Form IV profitably and done in Form V.

1. (a) If a is a whole number, what are the numbers immediately preceding and following it?

(b) If the sum of three consecutive numbers be 54, what are they?

2. If $2n+1$ denote any odd number, what are the odd numbers immediately preceding and following it? If the sum of two consecutive odd numbers be 36, what are they?

3. AB is a straight line $x+y$ inches long. C is a point in the line such that $AC=3x-2y$ in. D is another point in the line $AC=DB$. Find in terms of x and y the length of CD. Evaluate the result when $x=6$, $y=4$.

4. A man wanted change for a five-rupee note. He got x two-anna pieces, $2x+4$ anna coins and $x-5$ four-anna pieces. Find x.

5. By selling a horse for Rs. a, a dealer would gain 4 times as much as he would lose if he sold it for Rs. b. Find in terms of a and b the cost of the horse.

If $a=160$ and $b=135$, find a numerical result.

6. The telegraph posts along a railway line are a yards apart. If a train clears n of these in 15 minutes, find its speed in miles per hour.

If the speed be 45 miles per hour and if $n=181$, find a.

7. A debt which might have been paid exactly with $16x+2$ rupees and $x+1$ five-rupee currency notes, was paid out of a hundred-rupee note and the balance received was $2x$ five-rupee currency notes. Find x and the amount of the debt.

8. If the simple interest on Rs. a for b years is Rs. c, find in terms of the letters involved the simple interest at the same rate on Rs. $(a+150)$ for $(b-2)$ years.

Evaluate your result when $a=800$, $b=3\frac{1}{2}$, $c=210$.

9. A cyclist riding steadily covers a distance of b miles in a hrs. and a wheel makes x revolutions a minute. Find in feet the radius of the wheel.

Find the radius when $a=3$, $b=31{\cdot}5$ and $x=126$.

10. Apples are bought at Rs. x a score and are sold at a profit of y per cent. How many are sold for a rupee?

If $x=6\frac{1}{4}$ and $y=60$, give a numerical answer by substitution.

11. In a race of x miles, A defeats B by y yards; if B runs z feet a second, find A's rate in miles per hour. If $x=2$, $y=220$, $z=15$, find a numerical result.

12. A has Rs. x and B has Rs. y. How must Rs. z be divided between them so that A may have three times as much as B in the end? If $x=40$, $y=18$, $z=30$, find their shares.

13. A man goes from A to B at a miles an hour and forthwith returns at b miles an hour. The total time taken

is c hours. How far is it from A to B? Evaluate the result $a=6$, $b=8$, $c=5\frac{1}{4}$.

14. A train whose speed is x miles an hour takes 1 hr. more than another train to go y miles. The latter runs at z miles an hour. Find y in terms of x and z.

15. Find in pounds the total cost of buying x articles at y for a shilling and y articles at x pence a dozen.

16. The populations of two countries are a and b; and these are at the rate of x persons and y persons respectively to the square mile. Find the average population per sq. mile in the two countries taken together.

17. A cricketeer played during a season x innings on the whole, part of which in England and the rest in Australia. His total average per innings was a runs. The number of innings played in England was y and his average for these was b. Find his average for the innings played in Australia.

Give a numerical answer when $x=24$, $a=45$, $y=16$, $b=48$.

18. A sum of Rs. x is distributed between A, B, and C. A receives twice as much as B, and C receives Rs. 20 less than A. Find the amount received by A in terms of x.

19. A tinker is employed by a merchant to make tin cans. The tinker is to be paid a fixed wage of a annas a day and an extra bonus of b pies for every article finished, over and above m articles. The tinker works h hours a day and finishes at the average rate of p cans per hour. Find E his weekly earnings in rupees, if he works throughout the week uniformly.

If $a=11$, $b=6$, $m=20$, $h=10$, $p=3$, find E by substitution in the relation.

20. When a man takes a leisurely walk he goes x furlongs in an hour and covers that distance by taking y steps a minute; when he walks fast he goes m miles an hour and takes n steps a minute. Find the difference in feet in the lengths of the steps in the two cases.

21. A merchant mixes a gallons of wine at x shillings a gallon with b gallons at y shillings a gallon. He sells the

mixture $18z$ shillings per gallon thereby gaining 20%. Establish a relation between a, b, x, y and z.

22. AB is a straight line, $2x$ inches long. It is bisected at C and divided at D so that CD is y inches long. Write down in terms of x and y the lengths of AD and DB.

23. AB is a straight line divided at C. If AB is a inches, BC is b inches, write down the length of AC. By how much is the square on AB larger than the sum of the squares on AC and BC ?

24. A man has x coins; of these a are half-rupees, b are quarter-annas and the rest are rupees. How many more rupees has he than half-rupees ?

25. A number of apples in a basket weighed 60 lbs.; n children each ate 3 apples and m other children each ate 2 apples. If the average weight of an apple is w ounces, how many pounds of apples were left in the basket ?

If $w=4$, $n=2m$, and 18 lbs. of apples were left, how many children were there ?

26. A book-shelf can hold a copies of Concise Oxford Dictionary or b copies of Modern Elementary Mathematics. If m copies of the Dictionary and n copies of Elementary Mathematics just fill it, find a relation between a, b, m and n.

27. A sovereign is worth Rs. 12-10-0. If s sovereigns could be purchased for Rs. a, and b annas, find a relation between s, a and b.

If $s=17$, $b=10$, find by substitution in the relation the value of a.

28. A research scholar who had just landed in England had with him a hundred-rupee notes and b ten-rupee notes. He gave them in a bank. How much in English money will be credited to his account if exchange rate be 1s. 4d. per rupee ?

29. By selling an article for Rs. a a merchant gains p% and if he had sold it for Rs. b he would have lost q%. Find the cost price in terms of a, b, p and q.

By proper substitutions in the result find the cost price of an article which gives a gain of 15%, if sold for

Rs. 86-4-0, but if sold for Rs. 65-10-0 would result in a loss of $12\frac{1}{2}\%$.

30. A certain sum of money amounts at simple interest to Rs. a in x years and to Rs. b in $x+3$ years. Find the principal in terms of a, b and x. Evaluate the result when $a=504$, $b=585$ and $x=2$.

31. A playground is of the shape of a rectangle ABCD with a semi-circle BEC on BC. If AB $=a$ yards and BC $=7b$ yards, find the perimeter of the field.

(i) Evaluate the result if $a=14$, $b=168$.

(ii) Given that in a field of the same shape, the length AB is 5 times the breadth BC and that once round the course is a mile, find the width of the rectangular part.

EXERCISE V-C

May profitably be taken up in Form VI.

1. Write down algebraically :—" Square a, divide by the square of b, add 1, extract the square root, multiply by w, divide by the square of n." Give the result in an elegant form.

2. (a) A can run x feet in a seconds : B in y seconds can run b ft. more than A ; C's rate is the average of the rate of the two. Find his rate z, in miles per hour in terms of x, y a and b.

(b) If $x=176$, $y=10$, $a=20.$, $b=11$, find z.

3. A man's annual income is Rs. R. He pays $p\%$ of this towards premiums to insurance and this amount is free from income-tax. On the rest he pays tax of 6 pies per rupee. If his monthly household expenses come in the aggregate to Rs. E, find his annual saving S in rupees, in terms of R, p, and E.

4. A railway passenger is charged x as. per mile by the first class., y pies per mile by second class, and z pies per mile by third class. A gentleman who goes a distance of

192 miles takes 2 first-class tickets, 2 second-class tickets and three third-class tickets. If A be the amount he paid in Rupees, establish a relation between A, x, y, and z.

5. In a work-shop a man earns a annas a day and a woman b annas a day. There are on the whole p people and the wages a day come to c annas. Find in terms of a, b, p and c, (i) the number of men (ii) the number of women, in the workshop.

6. If a apples cost two annas more than b oranges, and c apples cost twice as much as d oranges, find in Rupees, the cost of two hundred oranges. Give a numerical answer when,

$$a=4,\ b=12,\ c=8,\ d=15.$$

7. A man had in his purse x one-rupee coins and y one-anna pieces. He changed a certain number of rupees into one-anna coins and then the number in each kind was represented by $\frac{y+1}{5}$ and $5\ (4x-y)$respectively. The value in each case, of the contents was Rs. 55-10-0. Find how many coins of each kind he had originally.

8. There are b boys and g girls in a school. The average age of the boys exceeds that of the girls by a months. The average age of all the pupils is p years m months. Find in months the average age of the boys.

9. A man rides a distance of p miles and walks back at the rate of q miles an hour. The entire trip took t hours. Find his rate of riding.

10. A certain liquid is poured into a cylindrical vessel, to half its height, and the weight of the vessel and the water is a gms. When the vessel is full of water, they weigh b gms. What will be the weight of the vessel and the water if the water stands to $\frac{3}{4}$ of the height of the vessel?

11. There are a pages in a book. 3 pages are blank, the title-page has t lines of print; the preface occupies 2 pages and each page of preface has p lines. The rest is the body of the book which has on an average b lines of print on each page. If the total number of lines in the book be l, find a formula for b in terms of a, t, p and l.

If $a=540$, $t=20$, $p=28$, $l=20368$, find b.

12. There are two floors in a building and there are a rooms downstairs and b rooms upstairs. One room downstairs is used by the owner and the two end rooms fetch only half the rent of the other rooms each of which is let at Rs. m per month. The two end rooms upstairs are let only at half the rate of the other rooms there, each of which is let at Rs. n per room per month. The rent due is collected and the owner has p five-rupee currency notes. Find p in terms of other letters. If $a=32$, $b=26$, $m=6$ and $n=4$, find p.

13. (a) If two trains whose speeds are T and t miles an hour, start from the same place at the same time, how far will they be apart at the end of s minutes from the time of starting (i) if they run in opposite directions, (ii) if they run in the same direction ?

(b) Two trains running towards each other are 8 miles apart in six minutes from the time of crossing. If their speeds are as 9 : 7, find their rates in miles per hour.

14. (a) A straight line AB is $4(a+b)$ inches long. With centre A and radius $=3(a+b)$ inches, a circle is described to cut AB at P. Again with centre B and radius $=2(a+b)$ inches, another circle is described to cut BA in Q. Find in terms of a and b the length of QP.

(b) The area of a rectangle is S sq. inches, and its length is l inches. Find in terms of S and l (i) its perimeter (ii) its diagonal.

EXERCISE V-D

To be done in Form VI.

1. A piece of cloth is x yards y feet z inches long. If two pieces each a yards long be torn off and the remainder be cut into strips each s inches long, how many strips will there be?

2. A book-shelf is b feet long. If v volumes each a inches thick, and t volumes each c inches thick are placed in it, how many more volumes each x inches thick will the shelf accommodate?

3. There are x telegraph posts to the mile at equal distances apart.

(a) Find in feet the distance between two adjacent posts.

(b) If a train clears n of these in m seconds, find its rate in miles per hour.

4. The price of a house is Rs. x and that of the furniture in the house is Rs. y. If the house and the furniture together cost Rs. a, express the relation between x, y and a.

Again if the price of the house alone is b times the price of the furniture, find x and y separately in terms of a and b.

5. (a) A father is now x years old. What was his age a years ago?

(b) His son is now y years old. What was the son's age a years ago?

(c) If a years ago the father was twice as old as his son, write down the relation between x, y and a.

6. A husband is a years old and the wife b years. When they were married x years ago, the husband was half as old again as his wife. Find x.

7. The difference between the ages of two brothers is a. One of them is x years of age. b years hence the elder will be one-fourth as old again as the other. Find x in terms of a and b.

8. (a) A tank is rectangular and is a yards long and b

yards broad. To walk a distance of c miles, a person goes round the tank x times. Find x.

(b) If he goes p times round the tank, how many miles would he have walked ?

(c) If the man takes 15 minutes to go round the tank once, find (i) his rate in miles per hour, (ii) the time he took to take a walk of (1) c miles, (2) p times round the tank.

9. The number of coins I once paid to clear a V. P. P. was a. Some were two-anna pieces, and the rest one-rupee coins. The total amount of the V. P. P. was Rs. 4-12-0. If I had x one-rupee coins, find how many two-anna pieces there were in the amount I had paid.

10. A mason agreed to work for a days. It was stipulated that he should receive m annas for each day he worked and pay a fine of n annas for each day he was absent. If he was absent for x days, find how much he was entitled to.

11. A landowner finds the length and breadth of a rectangular piece of land by stepping along. If each step is on an average a inches and he takes x steps along the length and y steps along the breadth, find in terms a, x and y:

(a) P, the perimeter of the field.

(b) A, the area of the field.

(c) D, the diagonal of the field.

Evaluate these when $a = 2.75$, $x = 30$, $y = 22$.

12. Two persons stood for a certain election. The voting list had x voters; a did not vote, and of the recorded votes b were rejected as illegal. The successful candidate won by a majority of c votes. If v denote the number of votes he secured, establish a relation between x, a, b, c, and v. If $x = 3390$, $a = 50$, $b = 25$ and $v = 1720$, find c.

13. Two persons A and B, x miles apart, start at the same time and travel towards each other, A at a miles an hour and B at b miles an hour. Where will they meet ? If P be the distance in miles, of the meeting place, from the terminus wherefrom A started, express x in terms of P, a and b. Find x when $a = 3$, $b = 5$, and $P = 13{\cdot}875$; and P when $a = 3$, $b = 5$ and $x = 45$.

14. A workman is engaged for p days on condition he should receive q annas for every day he worked and pay a fine of r annas for every day he was absent. At the end of the period he received t annas. If he worked for x days and was absent for the remaining days, establish a relation between x, p, q, r and t.

If $p=35$, $q=20$, $r=6$ and $t=518$, find x.

15. There were a certain number of beggars, say x, and a gentleman had some rupees with him If he gave each beggar a annas, p annas remained, and if he gave each b annas, q more annas were needed. Find x in terms of a, b, p and q.

If $a=7$, $b=7\frac{1}{2}$, $p=6$, $q=25$, find x.

16. To reach a shrine a pilgrim has to walk a ft. up an incline, b ft. along the level, and c ft. down an incline. His rates of walking uphill, on level ground and downhill are respectively p, q and r ft. per minute. If T denote the hours he takes to reach the shrine, find the relation between T, a, b, c, p, q and r.

17. A man rides one-third of the distance from A to B at the rate of x miles an hour and the remainder at the rate of $2y$ miles per hour. If he had travelled at a uniform rate of $3z$ miles per hour he could have ridden A to B and back again in the same time. Establish a relation between x, y and z.

18. The average age of x boys in a school is a years. p boys left the school and the average was reduced by b years. Find the average age of the boys that left the school.

If T denote the average, evaluate T correct to one decimal place when $x=230$, $a=14$, $b=1$, $p=29$.

19. If a man buys x dozen apples at a annas per dozen, and y dozen apples at b Rs. a dozen and sells $\frac{3}{5}$ of the whole lot at $2a$ annas per dozen and the rest at Rs. $1\frac{1}{2}$ per dozen, find his profit in annas.

Find his profit when $x=5$, $a=12$, $y=3$ and $b=2$.

20. A, B, C and D are four brothers, a, b, c and d years of age respectively. A's age is equal to the sum of the ages

of B, C and D. If x years hence, A's will be half as much as the combined ages of B, C and D, find the relation between x, a, b, c and d.

21. A train has f first-class compartments, s second-class compartments and t third-class compartments. The charge per mile for each passenger is 1 anna, 6 pies, and $2\frac{1}{2}$ pies by each class respectively. If each first-class passenger travels on an average x miles, each second-class passenger y miles and each third-class passenger z miles, what will be the income to the company for the train, if each first-class compartment can hold 4 passengers, each second-class 3, and each third-class 64 passengers, supposing that the train carried the full complement of passengers?

22. m viss of ghee at Rs. 3-4-0 a viss are mixed with n viss at Rs. 3-8-0 a viss, and the mixture is sold at Rs. 3-5-0 a viss, and the seller neither gains nor loses. Establish a relation between m and n.

23. In an election, out of x voters, a were absent, b remained neutral and the remainder voted. The rival candidates were P, Q, and R; P got c more votes than R and Q was elected as he got as many votes as P and R together. Find in terms of x, a, b, c, how many votes each secured.

24. From a purse containing Rs. a, b as., a boy stole away a as. b ps. on each of m different occasions and the purse then contained x as. Write down the relation that must exist between x, a, m and b.

If $a=13$, $b=6$ and $x=92{\cdot}5$, find m.

25. A man must be at his destination in an hour. He runs a distance of p miles at a miles an hour, then walks a distance of q miles at b miles an hour and again runs at x miles an hour, and thus covers the total distance s miles in the hour. Find in terms of the other letters the value of x.

If the total distance be $4\frac{1}{2}$ miles, p, q, a, and b be respectively $1\frac{1}{2}$, 1, 4 and 3, find x.

EXERCISE V-E

Substitution in Formulæ

Easy—Form IV.

N.B.—The more important mensuration formulae are here catalogued.

Changing the Subject of the Formula

1. $A = lb$, gives the area A of a room in sq. ft., the length of the room being l ft. and its breadth b ft.

(a) Find A if $l = 18{\cdot}5$ and $b = 8{\cdot}75$.

(b) Express l in terms of A and b, and find l if $b = 8$ and $A = 320$.

(c) Express b in terms of A and l and find b if $l = 32$ and $A = 288$.

2. $W = 2h(l+b)$, gives the area of the four walls of a room in sq. ft.—l, b, h denoting the length, breadth and height respectively of the room in feet.

(a) Find l if $W = 600$, $b = 10$, $h = 12$
(b) „ h if $W = 575$, $l = 15$, $b = 12$
(c) „ b if $W = 500$, $l = 14$, $h = 10$
(d) „ W if $l = 20$, $b = 15$, $h = 12$

3. The length of a room is l ft., its breadth is b ft. and its height is h ft. Find in terms of l, b and h, the value of T, which denotes the total area of the four walls, floor and the ceiling of the room.

4. If a denote the area of a triangle in sq. ins., b the length of its base in inches and h the length of the perpendicular on the base in inches, then $A = \frac{1}{2}bh$.

Find b if $A = 24$, $h = 6$
„ h if $A = 20$, $b = 8$
„ A if $h = 7$, $b = 8$

5. If a and b denote the lengths in inches of the parallel sides of a trapezium, and h the distance in inches between parallels,

$$\frac{h\,(a+b)}{2} = A$$

where A denotes in sq. in. the area of the trapezium.

Express h in terms of A, a and b and a in terms of A, h and b. Also find b given that $A=135$, $h=10$, $a=12$.

6. $(ab)/2=\triangle$, gives the area $\triangle$ of a right angled triangle in sq. units, the lengths of the sides being a and b units.

Express a in terms of b and $\triangle$ } Find a if $b=6$ and $\triangle=15$
„ b in terms of a and $\triangle$ } „ b if $a=8$ and $\triangle=36$

7. The circumference of a circle of radius r is $c=2\pi r$; and the area $S=\pi r^2$. Find r if $S=9\pi$, $c=6\pi$, and S if $r=4$.

8. The area of a circle is $S=\pi r^2$; if d be the diameter $d=2r$; hence express S in terms of π and d. Find S if $d=4$.

9. The simple interest I, on a sum of money P, for n years at r per cent per annum is $(Pnr)/100$.

Express P in terms of I, n and r.

Find n if $P=125$, $I=10$, $r=4$
„ r if $P=150$, $I=15$, $n=2$
„ P if $I=60$, $n=6$, $r=3\frac{1}{3}$

Harder—Form V.

10. If a sum of Rs. P be lent at compound interst at r per cent per annum, then the amount A in rupees at the end of n years is,

$$\left(1+\frac{r}{100}\right)^n \times P,$$

Find A if $n=3$, $P=100$, $r=5$.
„ P if $A=1681$, $r=2{\cdot}5$, $n=2$.

11. If $\triangle$ denotes the area and s the semi-perimeter of a triangle the area is given by $\triangle=\sqrt{s(s-a)(s-b)(s-c)}$.

(i) Find the area if $a=12$, $b=15$ and $c=10$.

(ii) If $a=b=c$. find in terms of a. the value for $\triangle$. Note that the formula gives the area of an equilateral triangle on a base of a inches. Find in this case the area of an equilateral triangle on a base of 4 inches.

12. The volume v of a cylinder is $v=\pi r^2 h$, where r is the radius of the base and h is the height.

Find v if $r=3$, $h=4$
„ r if $v=12\pi$, $h=3$
„ h if $v=80\pi$, $r=4$.

13. The entire surface of a solid cylinder (the curved surface and the two flat ends), is $C=2\pi r(r+h)$.

Find C if $r=2$, $h=3$
„ r if $C=42\pi$, $h=4$
„ h if $C=80\pi$, $r=4$.

14. If S denote in sq. inches the curved surface of a cone the radius of whose base is r inches, the height in inches being denoted by h, then $S=\pi r\sqrt{r^2+h^2}$.

Find S if $r=3$, $h=4$
„ h if $S=16\pi$, $r=2$
„ h if $S=30\pi$, $r=3$.

15. The volume V, of a cone whose height is h inches and the radius of whose base is r inches is $V=\frac{1}{3}\pi r^2 h$.

Find V, if $r=6$, $h=8$
„ r if $V=12\pi$, $h=4$
„ h if $V=26\frac{2}{3}\pi$, $r=4$.

16. If a body weighs W grams in air and w grams in water, its specific gravity S is $W/(W-w)$. Find w in terms of W and S. If $S=19$, $W=34$, find w.

17. The distance s feet fallen in time t seconds by a bomb dropped from an aeroplane vertically downwards is given by the formula, $s=ut+\frac{1}{2}gt^2$, where u denotes the initial velocity of the bomb.

(i) If $g=32$, $u=40$ and $t=18$, find s the height of the aeroplane.
(ii) Also express u in terms of s, g and t.
(iii) „ „ g „ s, u and t.

18. If a certain temperature is F degrees Farenheit and the same temperature is C degrees Centigrade.

$$F=32+\frac{9C}{5}$$

Express C in terms of F and find C when $F=86$.

EXERCISE-VI

Averages

To be done in Form IV.

1. Find the averages of the following sets of numbers :—
   (i) 7, 12, 9, 7, 10.
   (ii) 12, 9, 17, 48.
   (iii) 13, 6, 12, 19, 20.
   (iv) 7, 9, 6, 10, 11, 24, 18, 3.

2. The prices per hundred of cocoanuts are Rs. 5-0-0, Rs. 6-0-0, Rs. 5-8-0 according to sizes. If I buy 100 of each of the three sizes, find the average price per hundred.

3. One woman offers 40 bringals for two annas, another, 50 for four annas and a third 400 for a rupee. Find the average price per hundred.

4. I purchased 4 viss of sugar at Re. 0-7-6 per viss in one shop, 6 viss more at Re. 0-8-0 per viss in another and 2 viss at Re. 0-8-0 per viss in a third. Find the average price per viss.

5. A boy weighed a certain piece of metal and noted down 40·8 gr., 38·9 gr., and 40·3 gr., on three occasions. What is the average of these three results.

6. The depths of water during 6 months in a well were 18ft., 14ft., 9ft., 13ft., 16ft. and 11ft. Find the average depth.

7. Of 40 boys in a class 18 are of 12 years of age, 12 are of 14 years and 10 more are 13 years. Find the average age of each boy.

8. The marks obtained in an examination by boys are as follows. 10 obtained 60, 20 more obtained 45 and the remaining 20 got 30 each. Find the average for the class.

9. If the average of 6 numbers is 17 and the average of 9 other numbers 18, find the average of the whole.

10. The area of a certain piece of land is an acre and there are 1200 plantain trees uniformly spread. How much space is allowed per tree ?

11. In a class of 24 boys 18 boys weigh on an average 7 stones 2lbs. and 5 more boys 6 stones 12lbs. Find the weight of the remaining boys if the average weight per pupil for the whole class be 7 stones.

12. The average rainfall per month in a certain year was 4·8 inches. If it was 6·2 inches in the first 6 months and 2·8 inches in the last 5 months what was the rainfall in the 7th. month ?

13. The depths of a river straight across at equal distances from the bank were 0, 2, 4, $5\frac{1}{2}$, $6\frac{1}{2}$, 8, 10, 12, $10\frac{1}{2}$, $9\frac{1}{2}$, 8, 6, 4, 2, 1, 0. Find the average depth.

14. The price per piece of cloth varied as follows :— Rs. 6-0-0, Rs. 6-4-0, Rs. 5-12-0, Rs. 4-8-0. Find the average price. If the average price for 5 periods be Rs. 5-10-0, what was the price on the 5th period ?

15. On six months consecutively I was told that the prices of sovereigns were Rs. 17-12-0, Rs. 17-6-0, Rs. 17-14-0, Rs. 18-0-0, Rs. 18-2-0, Rs. 18-6-0. Find the average price. If the average for the year was Rs. 17-12-0, what was the average for the remaining 6 months ?

16. If the average of 12 numbers is x and that of 10 of these is y, find the average of the remaining two. If $x=18$, $y=16$, find the average.

17. If the average of m numbers is 7 and that the average of n other numbers is 8·5, find the average of the whole. If $m=6$ and $n=4$, find the average.

18. There were 12 boys in a class. The average weight of each boy was 52·5 lbs. 3 more boys joined the class. They weighed 48, 53, 49 lbs. respectively. Find the new average weight of the 15 boys.

19. The average weight of 16 boys in a class is 68·25. Two boys weighing 58 lbs. and 68 lbs. leave the class. Find the average of the remainder.

20. A cricketeer had played 12 innings and the average of the runs was 72·25. He played 3 more innings and raised his average to 75. If, in the first innings he got 3 more than in the second and in the third 6 less than the second, how many runs did he secure in each of the 3 innings ?

21. In a class of 40 boys, if the average in mathematics is 38·5, four get the maximum and 6 get zero, what is the average of the remainder?

22. A fruit seller buys oranges as follows :—650 oranges at Rs. 12-0-0 per 100, 420 oranges at Rs. 15-0-0 per 100, 240 oranges at Rs. 9-0-0 per 100 and 480 oranges at Rs. 13-0-0 per 100. He has to spend Rs. 43-8-0 to carry them to the market. Find the average price per 100.

EXERCISE VII-A

Percentages—Easy Types

To be done in Form IV.

1. The maximum for one paper is 100 and for the other 60. A boy must get 35% of the total to get a pass. If he secures 42 in the former, how much per cent must he get in the other for a pass?

2. A cycle is sold for Rs. 66-0-0 and the dealer thereby gains 10%. What it should have been sold for to gain 25%?

3. The price per viss of sugar was Re. 0-8-0. If the price falls by 25%, by how much can I increase consumption?

4. A boy gets 36% in a subject to a maximum of 80
25% " " " 60
48% " " " 75
Find his average per cent correct 1 decl. place.

5. In a village there are 860 males, and 1100 females. If the male population increases by 10% and the females by 12%, find the increase per cent in the total population correct to 1 decl. place.

6. The wholesale price per bag of rice was Rs. 12-8-0 and a dealer was selling at a gain of $6\frac{1}{4}$% on this price. If the wholesale price falls by 25%, what will be his profit per cent if he sells for the same sum as before?

7. A house holder has to spend Rs 20-0-0 per month on luxuries and Rs. 60-0-0 per month on necessaries. If owing

to increase in prices, necessaries increase by 15% in cost, by how much per cent must he cut off his expenses on luxuries?

8. From the face value of books published 20% is to be deducted for cost of printing, 18% for discount to book-sellers, 6% for advertising expenses and the remainder is divided between the author and publisher in the ratio of 4:3. If the author gets Rs 784, find the face value of books sold.

9. A man begins business with a capital of Rs. 600-0-0. In the first year he loses 15%. With the balance he again continues the business. If he now gains 20% on his capital, how much will he have at the end of two years?

10. A person pays tax which comes to $6\frac{1}{4}\%$ of his income. If after paying tax his net income is Rs. 1,500-0-0, find his gross income.

11. A mirasdar has to pay 15% of his income to tax, 25% more to life-insurance and 48 per cent more towards household expenses. If of the savings he gives $\frac{1}{6}$ to charity and saves Rs. 1,250-0-0 every year, find his annual income.

12. Goods are sold at a loss of $7\frac{1}{2}$ per cent; had they been sold at a gain of $7\frac{1}{2}$ per cent, the merchant would have realised Rs. 75-0-0 more. Find the cost of goods.

13. During a certain census the population of *G. B.* was 21,476,000 and that of *I.*, 7,310,000; in the next census the former had increased by 8·45 per cent and the latter had decreased by 12·5 per cent. Find the increase per cent on the whole.

14. A man travels from *A* to *B* to buy goods which he can get 10% cheaper in *B* than in *A*. If the expenses of the journey come to Rs. 15-0-0 and he still makes a saving of Rs. 10-0-0, what does he pay for the goods?

15. (*a*) Express the fraction $\frac{3}{10}$ as a percentage; also $\frac{2}{5}\%$ as a fraction.

(*b*) What % does a grocer gain or lose by purchasing match boxes at Re. 1-8-0 a gross and selling them at 3 ps. each?

16. The strength of a certain school in 1930 was 630. This was 10% less than in 1929. If in 1931 the strength

rose by 20% of the strength in 1930, find the increase per cent on the strength of 1929.

17. A person sold a horse at a loss of 20% on the cost. If he had received Rs. 150-0-0 more for it, he would have gained 10% on the cost. Find the cost price.

18. The gross rental of a farm is £ 520. The owner pays income-tax at 7d. in the £ and then 5% of the remainder to the collector of the rent. How much will the owner himself receive.

19. If 12% of an army was disabled in the first month, 15% of the remainder in the second month and 10% of the latter remainder in the third month, the strength of the army left would be 33,660. Find the original strength.

20. A man buys an article and sells it at a profit of 10%. If he had bought it at 10% less and sold it for 6d. less, he would have made a profit of 20%. Find the cost price.

21. A shopkeeper sells an article so as to make 25% on the cost price. If he had sold it for 6d. more, he would have made 30%. What is the selling price ?

22. A man buys 500 eggs for £ 1-15-5 and sells 200 of them at 8 a shilling. At what rate must he sell the remainder if he is to make 25% on his outlay ?

23. A man bought goods and sold $\frac{1}{3}$ of it at a gain of 20%, $\frac{1}{5}$ of it at a gain of 40% and the rest at a loss of 5%. What per cent. did he gain or lose on the whole ?

24. A man spends 65% of his income and saves £ 434-0-0. What is the amount of his income and what sum does he spend ?

25. A shopman bought eggs at the rate of 7 for a shilling and sold them at a profit of 40%. How many eggs would a customer get for a shilling ?

EXERCISE VII-B

Percentages—Profit and Loss and Mixtures

N.B.—May be tried in Form IV and done in Form V.

1. The population of a town in 1890 was 12,290 a decrease of $8\frac{1}{3}\%$ of the census of 1880; in 1880 there was an increase of $7\frac{1}{2}\%$ of the census of 1870. What was the population in 1870?

2. Of the population of a district 2% died from all causes and 21·5% of the deaths was due to cholera. If the deaths from other causes exceeded the deaths from cholera by 912, find the total population.

3. In 1921 a merchant was selling an article at a price 40% above its selling price in 1914. By how much per cent. would he have required to reduce it, to bring it back to its 1914 price? If he reduced the 1921 price by 20%, how much per cent. would it still be above the price of 1914?

4. If 100 oranges be bought for Rs 23-8-0 and sold in retail, what must be the price of an orange, that 6 per cent. of the amount realised may be profit?

5. A grocer by selling 12 viss of sugar for a certain sum gained 20%. If sugar advances 10% in the wholesale market, what per cent. will the grocer now gain by selling 10 viss for the same sum?

6. A cycle-dealer bought 60 cycles an Rs. 175-0-0 each. He sold a certain number at a gain of 40 per cent. and each of the remainder at three-fifths of the selling price of each of the former, and thereby gained Rs. 2,730. How many did he sell at the lower rate?

7. (*a*) I bought an article for Rs. x and selling it at a gain of x per cent cleared Rs. 36-0-0. Find the cost price.

(*b*) I bought an article for Rs. $(x+5)$ and selling it at a gain of $(x+5)\%$ cleared Rs. 12-4-0. How much would I have gained, if I had bought it for Rs. x and sold it at a gain of (i) $x\%$ (ii) $(x+5)\%$?

8. (*a*) A merchant sells coffee seeds wholesale at Rs. 125-0-0 per bag of 50 viss and also retails at Rs. 2-10-0 per viss. If he gains 25% in the wholesale rate, what profit per cent. will he get in the retail?

(*b*) If he sells $\frac{2}{3}$ of his whole stock wholesale and the remainder in retail, what average gain per cent. does he make?

9. (*a*) A tradesman has marked his goods at an advance of 20% on the cost price. The sale-proceeds in a week come up to Rs. 375-0-0 If he has to spend 10% of the proceeds towards rent, establishment, etc. find his net profit that week.

(*b*) If, after deducting 10 per cent of the weekly takings, the tradesman wants to gain 20 per cent., at what profit per cent must he mark his goods?

10. A restaurant keeper bought 160 lbs. of ice at Re. 0-2-6 per pound. A certain portion melted away and having sold the remainder at Re. 0-4-0 per lb., he gained 40 per cent on his outlay, Find what portion of the whole stock did melt away.

11. An armourer undertakes to supply 2000 swords at 17s. 3d. each. He estimates that if 5 per cent fail to stand the required test and are not paid for, the profit will be 15 per cent on his outlay. At the trial 35 per cent prove worthless and are not paid for. Find his loss.

12. A tradesman was selling his articles at a profit of 36 per cent. The cost to him of the goods was reduced by $2\frac{1}{2}$ annas per article and he also deducted $2\frac{1}{2}$ annas from the selling price of each article and thus gained 40 per cent. What was the cost to him of an article originally?

13. A contractor estimated the cost of a building at Rs. 24,000. Two-thirds of this amount was for materials and the remainder for labour. He gave the tender at 15% above the estimated cost. When a fourth of the work was over, cost of materials rose by 10% and when half the work was over, wages increased 15%. What fraction of his estimated profit did he get, supposing he purchased materials as occasion arose? What was the actual gain made?

U.D.C. No: 512.512.1 SUR.

14. A cloth merchant had to clear his goods. He sold silks at a reduction of $37\frac{1}{2}\%$, cotton goods at a reduction of 15%, and woollen goods at a reduction of 20% on the prices marked and realised Rs. 425-0-0. Rs. 1,232-8-0 and Rs. 764-0-0 respectively. If the marked prices were 25% in advance of the prices he had paid for the goods, find his total gain or loss per cent. in the clearance sale.

15. When two years ago, one rupee weight of pure silver cost 0-12-0 I purchased pure silver for Rs. 120-0-0 and made into a dish. I had to pay an extra Rs. 10-0-0 towards making charges and wastage. If I sell it now for the net weight of silver at 0-11-0 per rupee weight, how much will I lose if in the two years it had lost 1·5% of its original weight? Give the answer to the nearest anna.

16. A merchant marked his goods at an advance of 25 per cent on the cost price. At this price he cleared $\frac{1}{3}$ of his stock when he found that a portion was damaged and could not be sold. He therefore raised the price of the remainder by 10 per cent of the prices already marked and gained 15 per cent on the whole. What fraction of the goods was damaged?

17. A merchant bought season goods for Rs. 3,000 and marked it at an advance of 25 per cent on the cost price. At this rate he sold $\frac{1}{3}$ of the stock, when he found that two-fifths of the remainder was damaged and was unsaleable. There was however a huge demand, and he therefore enhanced the price of the remainder by 30 per cent of the prices already marked. If the whole stock was cleared, find his gain per cent. on the whole.

18. A manufacturer supplies articles to two firms A and B. On articles supplied to the former he makes a profit of 20 per cent., and on articles sold to the latter he makes a profit of only 15 per cent. as the latter takes a larger quantity. If firm A sells the article at a profit of 20 per cent. and firm B also at a profit of 20 per cent., find how much a person can save by buying at the cheaper firm the articles, for which he had paid Rs. 480-0-0 at the dearer. Also find the cost of manufacture of the articles he purchased.

19. A person invested Rs. 2,000-0-0 in a business, stocked articles which he sold at 10 per cent. profit. The stock was exhausted in six months and with the money realised he bought fresh stock which he, selling at the same profit per cent., disposed of, in the next six months. Another who started business with the same capital on the same day sold his goods at a profit of 8 per cent but turned the capital and profit over once in 4 months. Who would have got the greater profit and find to the nearest rupee the excess of profit.

20. A trader authorised his agent to start a trade with a capital of Rs. 3,000. He bought goods on commission of $2\frac{1}{2}$ per cent. which he kept for himself, and the trader allowed him $5\frac{5}{9}$ per cent. commission on the profits. The agent thus got Rs. 94-8-0. What profit per cent. did the trader get? What profit per cent. did the agent realise on the actual amount invested?

21. A retail dealer bought 90, $\frac{1}{2}$-viss packets of coffee seeds at Rs. 3-4-0 per viss. He gently opened the flaps of the packets and drew out from each packet, 2 palams of coffee seeds, and packed the quantity drawn out also into so-called $\frac{1}{2}$-viss packets. If he sold each packet at Re. 1-12-0 find (*a*) his gain, (*b*) his gain per cent.

22. It was ascertained that 72 per cent. of the weight of a certain ore was metal; but when 485 tons of the ore were smelted, only $287\frac{1}{2}$ tons of metal were obtained. What percentage represents loss in the process of smelting?

23. The Motor fare between two towns was enhanced by 20 per cent. As a consequence there was a fall in the number of passengers, though the average receipts continued to be the same. Find the percentage fall in the number of passengers.

24. A man leaves 60 per cent. of his property to be divided between his wife and three brothers in the ratio $1 : \frac{1}{2} : \frac{1}{3} : \frac{1}{4}$ and the remainder to be divided between his nephew and niece in the ratio 3 : 2. Express the share of each as a percentage of the whole property.

25. In London there were, in one week, 1577 deaths, equivalent to a death-rate of 19 per thousand per annum, while in Greater London (which includes an additional suburban ring) there were 2047 deaths equivalent to a death-rate of 17·8. Find the population of London and calculate the death-rate for that week of the outer ring alone. Take one year = 52 weeks.

26. A goldsmith has two alloys of gold first being $\frac{3}{4}$ pure gold, the second $\frac{5}{12}$ pure gold. How much of each must he take to produce 100 ounces of an alloy which shall be $\frac{2}{3}$ pure gold.

27. An alloy of copper and zinc contains 72 per cent of copper; a second alloy of zinc and tin contains 64 per cent of zinc and a third alloy of tin and copper contains 48 per cent of tin. If these three alloys be mixed in the ratio of 1 : 2 : 3, what percentage of copper zinc, and tin is there in the mixture?

28. Sixty per cent. of a certain ore is metal: while another ore of the same metal contains 75 per cent. metal. If 480 tons of the former and 360 of the latter be smelted together, find (i) the percentage of metal in the whole, (ii) the metal actually obtained if 20 per cent. of the metal be lost in smelting.

EXERCISE VII-C

Harder—To be done in Form VI.

1. The pre-war and post-war prices of certain varieties of tennis bats are given below. Find the percentage increase in each case.

	Pre-War Price.		Post-War Price.	
	Rs.	As.	Rs.	As.
Tropical Doherty ...	32	8	42	4
Spalding Gold-medal ...	35	8	44	6
Prosser's Improved Phenomenon	35	0	49	0
Davis Risely Hexagon ...	34	8	38	13

(a) If a club orders for one of each variety and the company supplies them at the enhanced rates allowing 20% discount on the bill, find what per cent of the pre-war rates, the club paid in excess for the four bats together.

2. Five thousand copies are issued of a book, the price of which is Rs. 3-0-0 per copy; the cost of printing is 0-8-0 per copy, binding Rs. 2-0-0 per dozen, and carriage, advertising, etc. Re. 1-0-0 per dozen; the publisher disposes of them to the retail bookseller charging 25 copies as 24 and 30% less than the selling price, and upon the whole receipts takes 10 per cent commission for himself and gives the balance to the author. How much does the publisher, author and the retail bookseller respectively receive on this edition?

3. A contractor calculates to make 25 per cent on the actual cost of a house, and the engineer who prepares the design charges 5 per cent on the money paid to the contractor. If the owner after paying the contractor and the engineer, sells the house at a profit of 15 per cent and thereby gains Rs. 945-0-0, what did the house cost the contractor?

4. I publish 2,000 copies of a book at a cost of Rs. 300-0-0. I reserve 11 copies for my use and sell the rest to a book-seller at 0-8-0 each copy and count 13 copies in the dozen. How much per cent have I gained? If the book-seller sells at 0-9-0 each copy, find his gain per cent.

5. A manufacturer sells his goods 60% over the cost of manufacture, to a retail dealer allowing him 5% of this price for cash. The dealer puts his selling price 40% over his outlay, but allows his customers 10% discount for cash. By how much per cent is this selling price greater than the cost of manufacture?

6. A person purchased a lot of season goods and marked the prices at an advance of 35 per cent. on the cost price. He was able to sell at this rate only a third of the goods and the remainder was sold at a reduction of $12\frac{1}{2}$ per cent on the prices marked. The gain on the whole was Rs. 190-0-0. Find the amount of his investment.

7. A market woman bought a sackful of brinjals for Rs. 12-8-0. She sold half the quantity at 5 for 6 pies and the

remaining half at 1 pie each, and gained 10 per cent on the whole. How many were there in the sack ?

8. A Book-seller bought copies of a certain book at Re. 1-0-0 each. He was able to sell 100 of the number at a gain of $12\frac{1}{2}\%$ and the rest at a loss of $9\frac{3}{8}\%$ and gained Rs. 6-14-0 on the whole. Find the total number of copies

9. The published price of a book is 25% greater than the price charged to a bookseller for a single copy. When taking a quantity the bookseller gets 13 copies as 12. If the bookseller allows to purchasers a discount of 2 as. on each rupee of the published price, find his gain per cent (1) if he buys a single copy and sells it (ii) if he buys a quantity and retails it.

10. The receipts of a company amounted in one year to Rs. 177,000 and the expenses to Rs. 1,25,000. In the subsequent year, the receipts fell by 2% and the expenses increased by 1%. Find by what percentage of itself the profit in the first year exceeded the profit in the succeeding year.

11. (*a*) A wholesale dealer supplied goods to a retailer at a profit of 30% on what the goods had cost him. The retailer became a bankrupt and the court decreed a dividend of 11 as. 6 ps. in the rupee. How much did the wholasale dealer lose in the transaction ?

(*b*) If another wholesale dealer who had also supplied to the same retailer at the same rate, had done so, having received an advance of half the amount, what was his gain or loss per cent ?

12. (*a*) A coffee merchant was selling coffee at Rs. 3-12-0 a viss and thereby was gaining 25%. Owing to a fall in the price of the commodity due to a large produce in the estates, he had to cut down his price and reduced it so as to gain only Rs. 0-5-0 on each viss sold. In what ratio must his sale increase that he may make as much as he did before ?

(*b*) If, at the dearer rate, he was selling per month Rs. 1,500 worth of coffee seeds, how many viss per month must he sell at the latter reduced rate ?

13. A cycle dealer allowed a discount of 10 per cent on the catalogue prices of certain makes of cycles and a further discount of 5 per cent on this amount for cash and still made

a profit of $18\frac{3}{4}$ per cent. The wholesale prices of these cycles fell by $8\frac{1}{3}$ per cent and the dealer therefore cut down the catalogue prices by 5 per cent and offered the same concessions and discounts as before. What profit per cent. did he make ?

14. A manufacturer had marked his goods at an advance of 40 % on the cost price, but allowed a discount of 10 % on this price and a further reduction of $6\frac{1}{4}$ % on this last amount for cash. A retailer bought goods of the dealer for cash, and in his turn marked his goods at a price that would give him 25 % profit and allowed a discount of $12\frac{1}{2}$ % for cash. Find correct to one decimal place the excess per cent of the price paid by a cash customer on the cost of manufacture.

15. A publishing company offered an author 25% of the sales or 35 % of the profits. If a copies of the book were printed and sold at Rs. b each and if the total cost of printing, advertising, etc. be Rs. c and if the author gets the same amount by either method, find the relation between a, b and c. If $a=1{,}500$, $b=2\frac{1}{2}$, find c.

16. At a clearance sale books were sold 10% below, glassware 15% below, and piece-goods 25% below their catalogued prices. The amounts realised under the respective heads were Rs. 202-8-0; Rs. 518-8-0. and Rs. 461-4-0. If the catalogue prices were fixed at a uniform profit of 25% on the actual cost price find (1) the total catalogue prices of goods sold, (2) the total cost price of goods sold, and (3) the net gain or loss in the clearance sale.

17. A dealer bought two bicycles of two different firms, the price of one being 10% cheaper than the other. He sold the dearer for Rs. 282-0-0 and made 20% thereby. If he should gain 25% on the whole, what profit should he get on the other ? Express this profit as a percentage of the cost of that machine, correct to two decimal places.

18. In a certain district there are two schools. In the first 20 % are Mohammedans, 50 % Christians and the remainder Hindus. The second school contains only Christians and Hindus. If the two schools were amalgamated there would be 8 % Mohammedans and 56 % Christians.

Find the percentages of the Christians and Hindus in the second school.

19. The Waterman's Ideal Fountain Pen 'Regular Type' is quoted at 12s. 6d. by the company in England. The importing company has to pay $22\frac{1}{2}\%$ of the cost for customs duty, packing, etc. Exchange is at 1s. $5\frac{1}{8}$d. per Rupee. The company sells it in retail at Rs. 8-8-0 per pen and makes $12\frac{1}{2}\%$ profit. What percentage discount is allowed for trade?

20. A cabinet maker undertook to supply 1,800 chairs to a club and fixed a price that would give him $18\frac{3}{4}\%$ profit even though 5% of the number supplied failed to stand the test and would not be paid for. At the trial 12% failed to satisfy the management and these chairs were not paid for. The cabinet maker however gained Rs. 855-0-0. What did each chair actually cost him and at what price did he quote?

21. A manufactory turns out 50 tons of iron goods weekly, using up for the purpose, 51 tons of iron at £ 6-15s. a ton, 100 tons of coal at 11s. 6d. per ton, and £ 45 worth of other materials; rent, rates and taxes amount to £ 219 annually; wages, incidental expenses, £ 75 per week. At what price per cwt. must the iron goods be sold in order that the works may gain 8 per cent per annum on a capital of £ 35,000?

22. Two persons A and B speculated in different ventures with capitals of Rs. 13,000 and Rs. 9,000 respectively. The former had been more fortunate and gained Rs. 3 for every rupee gained by the latter. If the latter has doubled his capital, how much per cent has the former gained?

23. A tradesman has been accustomed to give his customers six month's credit and has marked his goods at such a price that would give him 12% interest on the selling price. He however wants to introduce the readymoney system into his business. By what percentage of the marked price should he cut down the prices? What would be the cash price of articles marked Rs. 13-4-0, Rs. 66-4-0, respectively?

24. At what rate per cent profit must a tradesman mark his goods that he may allow 4% of the sales for bad debts, $7\frac{1}{4}\%$ of the cost of goods for expenses, an average credit of

8 months and yet make a profit of $12\frac{1}{2}\%$ money being worth 15% ?

25. The net prices of goods described in a catalogue are 15% less than the catalogue prices, while a further discount of 5% on the net prices is given for cash payments. A customer however, higgles and obtains 20% off the catalogue price and finds that by so doing he has gained Rs. 4-10-6. What was the catalogue value of the goods he bought ?

26. To make an article takes $2\frac{1}{2}\%$ hours of a workman's time paid at Rs. 0-7-6 an hour. The material 10% of which is wasted in the working, costs Rs. 0-10-0 a pound. The final weight of the article is 20 lbs. At what price must it be sold to gain 8% on the total cost ?

27. A contractor undertook to supply 1,000 bags of rice, each bag containing 50 measures of rice at $3\frac{3}{4}$ measures for a rupee. The bags were supplied and it was agreed that ten bags chosen at random should be measured and the average of these taken as the quantity in each bag. These bags had 50, 50, 49, $49\frac{3}{4}$, $49\frac{7}{8}$, $49\frac{3}{8}$, $48\frac{15}{16}$, $49\frac{3}{16}$, $48\frac{7}{8}$, 49, $46\frac{5}{8}$, measures respectively. If the contractor was paid as agreed, what per cent of the profit he expected did he get, if his estimated profit was $16\frac{2}{3}\%$?

28. (*a*) A certain article is 20% dearer at a firm A than at a firm B, while it is 10% cheaper in firm A than in a third firm C.

An article is bought of the cheapest firm for Rs. 22-8-0. What would it have cost if bought at either of the other two firms ?

(*b*) If this article had cost each firm only Rs. 20-0-0, what profit per cent did each firm expect at the prices quoted ?

29. A merchant marks his goods at an advance of 15% on the cost price. The wholesale price of the goods fell down and therefore the merchant had to offer a reduction of 15% on his marked price. If he had stocked his goods at the higher rate how much would he lose on an investment of Rs. 15,000-0-0 ?

30. A publisher estimates the actual cost of bringing out 100 copies of a book at Rs. 75-0-0. Find the retail price for each copy that he must fix so that, after spending $7\frac{1}{2}\%$ on the retail price on advertising, and giving the author 10 % of, and the retail dealer a discount of 20% on, the retail price, the publisher may gain 25% on the cost of publishing.

31. A motor-car is advertised in England for £ 300 ; freight, landing charges and chiefly customs come to 40 per cent of this advertised price. Exchange is at 1s $5\frac{1}{2}$ d. to the rupee. The same car is offered by a company at Madras for Rs. 4,620 and the company is said to gain 10 per cent thereby. If the company has to pay freight, landing charges and customs duty on the same scale as any one else should, find what discount is allowed to trade.

32. A tradesman marks his goods at a price that would give him 25% profit, even after allowing a reduction of 1 anna in the rupee off the marked price. If x denote the cost price in rupees and y the marked price in rupees, establish the relation between x and y.

Draw the graph of the relation and from the graph find the marked price of an article bought for Rs. 4-8-0. and the cost price of another marked Rs. 3-5-4.

33. A merchant who sold his goods at a profit of 10%, found that when he allowed $2\frac{1}{2}\%$ discount off his selling price, his business increased by $\frac{1}{3}$. Find whether his total profits were increased or diminished by adopting this plan and in what proportion.

34. A merchant sells toys for children. The cheapest is bought by him for 8 pies and the dearest for 10 as. He wants 25% gain on each article. Draw a graph (ready reckoner) from which he can read off the S. P. of every toy he has to sell. Find from the graph,

(i) the S. P. of articles purchased for 1 a.-8 ps; 2 a.-8 ps; 3 as ; and 7 as.

(ii) the S. P. of articles which he sells for 6 as ; 5 as.-6 ps.; 3 as. 6 ps. and 2 as.

EXERCISE VIII-A

Simple Interest

To be done in Form IV and revised in Form V.

1. Find the S. I on (Give the answer to the nearest anna)

(i) Rs. 650-0 0 for 2 years and 3 months at $6\frac{1}{4}\%$ per annum.

(ii) Rs. 1,250-0-0 for 1 year and 6 months at $7\frac{1}{2}\%$ per annum.

(iii) Rs. 4,800-0-0 for 1 year and 2 months at 9% per annum.

(iv) Rs. 50-0-0 for 6 months at 24% per annum.

2. If the simple interest on a certain sum,

(i) for 2 years 3 months at $6\frac{1}{4}\%$ be Rs. 105-7-6.

(ii) for 1 year 6 months at 12% be Rs. 81-0-0.

(iii) for 2 years 3 months at 9% be Rs. 45-5-0.

(iv) for 6 months and 20 days at 24% be Rs. 8-0-0,

find the sum in each case.

3. (i) If the yearly interest on £3,125-0-0 is £117-3-9d. what is the rate per cent ?

(ii) In what time will £ 550-0-0 amount to £ 653-2-6 reckoning S. I. at $2\frac{1}{2}\%$ per annum ?

(iii) Find the S. I on £ 256-13-4 for 5 years at 3% per annum.

Also calculate the income-tax on this income at the rate of 4s.-6d. in the £.

4. I purchase an estate for Rs. 28,000-0-0. Every year I get 560 kalams of paddy. If in a certain year I can sell the paddy only at Rs. 3-4-0 a kalam and pay the agent who works for me, $\frac{1}{2}$ anna on each rupee of income, find the rate per cent yield supposing no other expenses are incurred.

5. I want to place a fixed sum in the bank so that a charity might be conducted regularly. The bank promises

only $6\frac{1}{4}\%$. How much should I invest if drawing the annual interest I can spend monthly Rs. 15-0-0 in the charity ?

6. A gentleman invests now Rs. 4,800-0-0 in a bank paying $4\frac{1}{2}\%$ S. I. At the end of one year he draws Rs. 1,800-0-0 interest ; how much will he have in the bank at the end of the 2nd year ?

7. (i) A marwari demands 0-0-3 ps. interest per Rupee per day. What is this rate % ?

(ii) If at this rate a man pledges a jewel worth Rs. 85-0-0 and borrows Rs. 25-0-0, in how many days will the amount be equal to the value of the jewel ?

8. I borrow Rs. 4,000-0-0 at $7\frac{1}{2}\%$ S. I. and forthwith lend $\frac{1}{5}$ of it at 12%, $\frac{1}{4}$ of the remainder at 9% and the balance at $10\frac{1}{2}\%$ per annum. Find my gain in a year ?

9. A person lent Rs. 2,400-0-0 at 6% per annum, but the debtor became an insolvent and at the end of the year the court declared Rs. 0-10-0 per rupee dividend. How much will he get ?

10. A man buys a land and builds houses of three types. There are 20 of type A, 30 of type B and 24 of type C. The rent per house is Rs. 12, Rs. 8, Rs. 6 respectively per month. He gives one anna on each rupee to a man who collects the rent. If he spends Rs 200-0-0 per year for repairs and clears $7\frac{1}{2}\%$, how much to the nearest rupee did he spend on the houses ?

11. A certain sum of money put out at S. I. amounts to Rs. 504-0-0 in 3 years and to Rs. 540-0-0 in 5 years. Find the sum and the rate per cent.

12. A certain sum of money invested at 12 % yields S. I. the same amount as Rs. 570-0-0 more invested at 10%. Find the sum.

13. Divide Rs. 1,800-0-0 so that the interest on one portion at 6% and that on the other at 5% may together amount to Rs. 100-8-0.

14. If a land yields 40 kalams and if the price per kalam is Rs. 3-12-0, how much will the land reasonably fetch if money is worth 9 p. c. ?

15. A man purchased sovereigns last year at Rs. 13-12-0 each. If he sells them now at Rs. 18-4-0 each, what rate per cent interest has he secured ?

16. If a bicycle is sold to me on credit for Rs. 64-8-0 and 6 months' credit is allowed, what will be the actual cost if cash is paid supposing he charges $7\frac{1}{2}$ p. c. interest ?

17. What sum must now be invested at 5 p. c. simple interest to meet a debt of Rs. 9,000-0-0 due $3\frac{1}{2}$ years hence, with 3 p. c. simple interest ?

18. Find the simple interest on 417.53 francs for $2\frac{1}{2}$ years at $4\frac{3}{4}$ p. c. per annum to the nearest centime.

19. A man having capital to invest wishes to place it so that, after paying income-tax of a shilling in the £, he many have a return of 4 p. c. on his outlay. Find the rate of interest he expects. If his net savings amount to £ 190, find the capital invested.

20. Which is advantageous ?

(i) To sell a jewel now weighing 60 vrahanadais at Rs. 7-8-0 a vrahanadai or to wait for a year and borrow Rs. 450-0-0 at 9 p. c. if there is an assurance that sovereigns will sell at Rs. 20-0-0 each. A sovereign $= 2\frac{1}{4}$ vrahanadais.

21. An author expects a sure income of Rs. 5,000-0-0 in a year from books ; on this he will have to pay tax at 1 anna per rupee. How much can be borrow now at 12 per cent if he should pay back the loan entirely from the books ?

22. A man has £ 4,000 ; he lends £ 500 at $3\frac{1}{2}$ p. c. and £ 2,000 at 4 p. c. At what rate must he lend the remainder of his money so that his total income may be $4\frac{1}{2}$ p. c. on his £ 4,000.

23. A man borrows Rs. 250-0-0 for 9 months at 3 p. c. per annum and by immediately lending it out for the same period at a higher rate of interest, he makes a profit of Rs. 2-13-0. What rate of interest does he charge ?

24. After paying a profession tax at 4 ps. out of every rupee in his income, a man deposits half the remainder in a bank. If he gets Rs. 47-0-0 for interest at 5 per cent, find his salary.

EXERCISE VIII—B

Problems, Chiefiy Inverse Types on Compound Interest

Some difficult types are given below. They will be gone through in Form VI. A variety of interesting problems has been given in Book II and in the Miscellaneous Examples and Revision papers that follow. Also standard questions may be taken from the S. S. L. C. papers, appended.

1. (*a*) Find the compound interest on Rs. 1,800-0-0 for 2 years at 5 %.

(*b*) Find the compound interest on £ 1,750-0-0 for 1 year at 12 % interest being compounded half-yearly.

(*c*) Find to the nearest anna the compound interest on Rs. 4,850-0-0 at 7 % for two years.

(*d*) Find to the nearest anna the compound interest on Rs. 4,650-0-0 at 12% for two years.

2. The interest on a certain sum of money at 8% for two years is Rs. 1,248 interest being added to the principal at the end of each year. Find the principal.

3. A boy was told that if he would be given in cash the difference between the compound interest and simple interest on Rs. 2,750 at 6 per cent for two years if he calculated it correctly. If he did correctly, how much did he get to the nearest anna ?

4. A certain sum put out at oompound interest amounts to £ 270·4 in two years and to £ 281·216 in three years. Find the sum and the rate per cent.

5. Find the sum for which the difference between the simple and compound interest at 5 per cent per annum for 3 years is £ 12-4*s*-0*d*.

6. If Rs. 32,000-0-0, put out at compound interest amount in 2 years to Rs. $34{,}279\frac{1}{5}$, find the rate of interest.

7. The difference between the simple and compound interest on a certain sum of money invested for 2 years at 8 per cent is Rs. 46-0-0. Find the sum.

8. A sum of money put out at C. I. amounts in 1 year to £ 4,200 and in 3 years to £ 4,630-10sh. Find the rate and the sum.

9. The compound interest for 2 years at 6 per cent per annum on a certain sum is the same as the simple interest on Rs. 4,944-0-0 for $2\frac{1}{2}$ years at 5 per cent. Find the sum.

10. A certain sum of money lent at 5 per cent compound interest amounts to £ 749-14sh. in two years and to £ 714-0-0 in one year. Find the rate and the sum lent.

11. Two-thirds of a certain sum is lent at 5 per cent, compound interest and the remainder at 6 per cent S. I. The two amounts are collected at the end of two years. The total amount received is Rs. 6,650-0-0. How much was lent at each rate ?

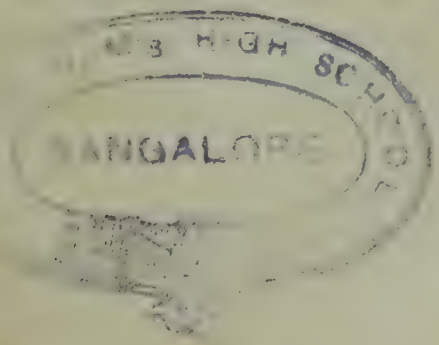
12. Which will be advantageous at the end of two years from now ?

(i) To lend Rs. 800-0-0 at 12 per cent C. I. or to lend Rs. 400-0-0 at 18 per cent S. I. and invest the other half in a lease which will bring about 40 kalams worth Rs. 5-4-0 a kalam every year. The amount realised at the end of the first year from sales may also be lent out at 9 per cent.

13. A sum of money was put out at C. I.; first year's interest was £ 65-2-1 and the fourth year's interest was £ 73-4-8. Find the principal and the rate per cent.

Hint :—£ 65-2-1 amounts to 73-4-8 in 3 years. Proceed at C.I.

14. A man borrows Rs. 820-0-0 at 5 per cent per annum compound interest and agrees to pay back the money in two equal annual instalments. Find the amount of each instalment.



EXERCISE IX

To be done in Form IV.

Or for revision in Forms V & VI.

On Proportion—Various Types

1. A family using 16 electric lights and 2 table-fans each 5 hours a day, pays Rs. 8-4-0 when the rate per unit is Re. 0-6-0. How many lights and 2 fans each working 4 hours a day, can a family use for Rs. 5-4-0 if the rate per unit is Rs. 0-3-6 ? given that a fan consumes the energy required for three lights.

2. If 6 compositors in 16 days of $10\frac{1}{2}$ hours each can set in type 45 formes of 16 pages each forme, a page containing 60 lines with 40 letters in a line: in how many days of 7 hours each will 9 compositors set 960 pages each of 45 lines with 50 letters in a line ?

3. An excursion was arranged. The party consisted of 60 persons. The tour lasted 18 days. The amount sanctioned was only Rs. 900-0-0 and they just managed it. Another party of 81 men started on the same tour ; but there were seniors and wanted some more comfort, their daily expenditure being $\frac{1}{3}$ as much again as that of the previous party. If a sum of Rs. 1,080-0-0, was sanctionend how long could they tour ?

4. Seven men caught in a desert had water enough for 13 days allowing $1\frac{3}{4}$ pints per man ; after 5 days, some water escaped and one man died and the water still lasted 13 days ; how much water was lost ?

5. An army has provisions for 48 days allowing full rations. If reinforcements arrive and the strength is increased by a third, by what fraction should the rations be reduced if they want to hold out for 36 days ?

6. A can do a piece of work in 8 days and B can do it in 12 days. If they together work for 4 days and then A leaves, how long will it take B to finish it ? If for the whole work they receive Rs. 8-8-0, how much should each take ?

7. A can do in 9 days what B can do in 6 days. If B alone can do a piece of work in 16 days, how long will it take for both of them to finish the work together ?

8. If A and B can together do a piece of work in 15 days and A alone can do it in 20 days, how long will B by himself require to do the work?

9. A piece of work can be done by 84 men in 25 days or by 75 women in 42 days. In how many days can the same work be done by 48 men and 78 women working together?

10. If 6 masons and 6 coolies can raise a wall in 4 days working 9 hours a day, how many coolies with 10 masons will be required to raise the same wall in 3 days working 10 hours a day, if a mason works half as much again as a cooly?

11. A farmer engaged a number of men and boys to reap corn. The men were to receive 4 as. a day each and the boys $2\frac{1}{2}$ as. each. If the work of 3 boys be equal to that of 2 men and if 4 men and 5 boys would reap 22 acres in 4 days, what sum should 6 men and 7 boys receive for reaping 48 acres?

12. A can do a piece of work in 10 days, B in 8 and C in 12. They all begin to work together. Only C works from beginning to end. A leaves the work $3\frac{3}{5}$ days and B also $2\frac{2}{5}$ days before its completion. In what time is the work done?

13. If 6 men and 2 boys can reap 13 acres in 2 days and 7 men and 5 boys can reap 33 acres in 4 days, how long will it take 2 men and 2 boys to reap 10 acres?

14. Two houses are built; the first takes twice as long to build as the second and half as many men again are employed in building the first; their wages per hour are $\frac{1}{3}$ higher, and they work 10 hours a day and 6 days a week, while the others work only 8 hours a day and 5 days a week; the cost of the second in workmen's wages was £1,000-0-0. What was that of the first?

15. A cistern can be filled by opening one or more of three taps A, B, C; A alone can fill the cistern in 70 min., A and B together in 30 min. and A, B and C together in 24 min. How long would B alone and C alone take to fill the cistern?

16. A and B together began a piece of work which they could have done alone in 34 and 38 days respectively; A

continued until the work was finished, but B left him 4 days before its completion. In what time was the work done?

17. A, B and C together can do a piece of work in 20 days; after 6 days A gives up and is succeeded by D, who does half as much again as A, B or C could do in one day. When will the work be finished?

18. A can do a piece of work in 12 days, which B can do in 15 days and C in 20 days. If A start and be helped on alternate days by B and C, when will the work be finished, and who will be A's partner at the close?

19. A piece of work can be done by A and B together in 14 hours, or by B and C together in $10\frac{1}{2}$ hours, or by A and C together in 12 hours. In what time could each do it by himself?

20. A can do $\frac{1}{4}$ of a piece of work in $\frac{2}{5}$ of the time that it would take B to do $\frac{5}{6}$ of it and B can do $\frac{7}{8}$ of the same work in $\frac{1}{2}$ the time C would occupy in doing another piece of work half as large again as the first. If C can finish the first named piece of work in 6 hours, how long would A and B together be in doing it? Give the answer correct to 1 decimal place.

21. On a piece of work 3 men and 5 boys are employed who do half of it in 6 days. After this one more man and one more boy are put on and $\frac{1}{3}$ more of it is done in 3 days; how many more men must be put on, that the whole may be completed in one day more?

22. If 175 men and 240 boys do in 1330 days the same amount of work as 603 men and 1005 boys in 350 days, compare the average daily work done by each man with that done by each boy.

23. A cistern holding 820 gallons is filled in 20 min. by 3 pipes, the first of which conveys per minute 10 gallons more and the second 5 gallons less than the third. How much flows through each pipe per minute?

EXERCISE X

The Geometry of the Circle

1. (*a*) The following names connected with the circle are already familiar to pupils.

(i) The **centre** of a circle.
(ii) The **radius** of a circle.
(iii) The **diameter** of a circle.
(iv) The **circumference** of a circle.
(v) The **area** of a circle.
(vi) The **sector** of a circle.

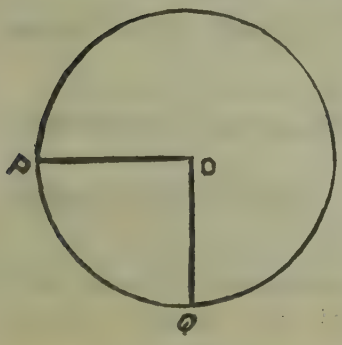
(*b*) The students know also that

The **circumference of a circle** $= \pi \times$ **diameter**
$= 2\pi r$ where r is the radius of the circle.

Also the **area of the circle** $= \pi r^2$ **or** $\frac{\pi d^2}{4}$
or Oce $\times \frac{1}{4}$ diameter.

How do you obtain $\frac{\pi d^2}{4}$? By substituting $\frac{d}{2}$ for r.

(*c*) The sector of a circle is the portion marked in the figure. If from the centre two radii are drawn, the circle is divided into two sectors. $\angle POQ$ is called the angle at the centre subtended by PQ. The area of the sector, (the pupils have been told) is the same fraction of the whole area of the circle, that the angle POQ is of the whole angle at the centre $= 360°$. Thus if angle $POQ = 80°$,



area of sector $POQ = \frac{80}{360}$ of the whole circle.

In general if $\angle POQ = x°$ and radius of the circle be r.

area of sector $POQ = \frac{x}{360} \times \pi r^2$ *i.e.*, $\frac{\pi r^2 x}{360}$ sq. units.

2. (*a*) We now proceed to derive the formula for area of a circle. Let PAB be a circle.

AOB a sector.

P_1, P_2, P_3 etc., points on the arc of the sector very very near so that,

$P_1P_2 = P_2P_3$ etc.

i.e., the arc is divided into a great number of very small equal parts.

Now area of OAP_1 is very nearly equal to the area of the triangle OAP_1.

for, P_1 is very very close to A and then arc AP_1 = chord AP_1.

Area of $\triangle OAP_1$ = area of sector OAP_1.

Area of $OAP_1 = \frac{1}{2}$ base $\times$ altitude.

Also perpendicular from O on AP_1 = the radius itself.

Hence area of sector $OAP_1 = \frac{1}{2}\ AP_1 \times OA$.

If AB be divided into n equal and very small parts,

$$\text{area of sector } OAB = n \times \tfrac{1}{2} AP_1 \times OA = \frac{n}{2}\ AP_1 \times OA.$$

but n times $AP_1 = AB$; for AB is divided into n equal parts.

$$\therefore \quad \frac{AB}{2} \times OA \text{ gives in sq. units the area of the sector.}$$

i.e. ½ **arc** × **radius**, *i.e.* $l/2 \times r$. .....where l is the length of arc and r the radius.

(*b*) If the whole circumference be divided into m parts each of which is very small, the student can at once deduce that there will be m sectors.

area of one sector $= \frac{1}{2} \times l \times r$.

$$m \text{ sectors} = \frac{ml}{2} \times r$$

but $ml = \text{O}^{\text{ce}}$.

$$= \text{Oce} \times \frac{r}{2} \text{ sq. units.}$$

$$= 2\pi r \times \frac{r}{2} \text{ sq units.}$$

$$= \pi r^2$$

This may or may not be taught in Form V.

The pupils have now two formulae to find the area of a sector.

(i) given radius and angle at cetre or ∠ at centre and length of arc.

(ii) length of arc and radius.

(*c*) (i) Draw any radius in a circle. Call it OM_1

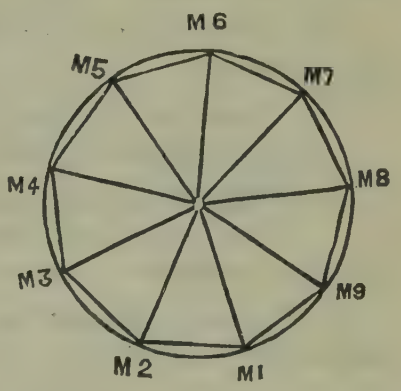
At O make an angleof 40°

Let $\angle M_1OM_2 = 40^\circ$

At O in M_2 O make an angle of 40°

i.e. $M_2OM_3 = 40^\circ$

Thus there will be 9 angles.



Also $M_1M_2 = M_2M_3 = M_3M_4 = M_4M_5 = M_5M_6 = M_6M_7 = M_7M_8 = M_8M_9 = M_9M_1$

Hence $M_1M_2M_3M_4M_5M_6M_7M_8M_9$ is a rectilineal figure all of whose sides are equal.

(ii) It will also be noted that the angles at the vertices are also equal. Such a figure whose sides and angles are all equal is called a regular polygon. A regular polygon is a figure bounded by straight lines. Its angles and sides are all equal.

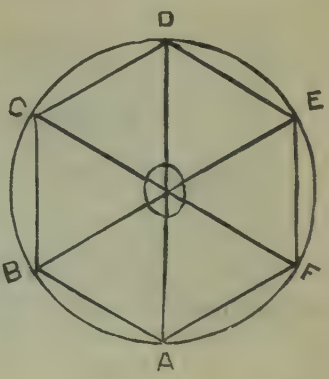
(*d*) (i) If a sector be drawn whose central angle $= 60^\circ$, there will be six such sectors and the chords of these sectors form a regular polygon of six sides.

A regular polygon of six sides is called—**A Regular Hexagon.**

(ii) In the regular hexagon $\angle AOB = 60^\circ$

$\therefore$ $\angle OBA = \angle OAB = 60^\circ$

$\therefore$ AOB is an equilateral $\triangle$



Similarly $\triangle$s, BOC, COD, DOE, EOF, FOA.

The regular hexagon is composed of 6 equilateral $\triangle$s.

and each side of the hexagon = the radius of the circle.

Hence to describe a regular hexagon whose side is given we have the two following methods.

(i) Draw a circle with the given side as radius.

Step off lengths *i.e.*, chords along O^{ce} = radius
Join them in order.

(ii) Describe an equilateral $\triangle$ on the side.
Six such equilateral $\triangle$s arranged form the regular hexagon.

(*e*) Let the radius of the circle or the side of the hexagon be denoted by $2a$.

Then the area of the equilateral $\triangle$ $= a^2\sqrt{3}$.

$\therefore$ the area of the regular hexagon $= 6a^2\sqrt{3}$.

N.B.—*At this stage we strongly recommend a revision of Art 97-A, Page 282, BK. II.*

(*f*) Let the side of a regular hexagon be denoted by $2a$.

Then the radius of the circumscribing circle is also $2a$.

,, ,, ,, inscribed circle is $a\sqrt{3}$.

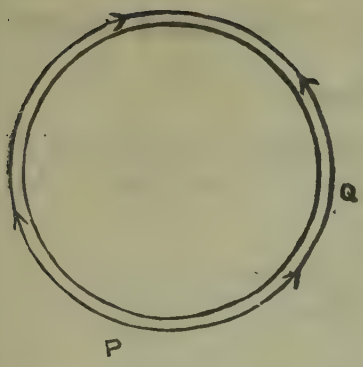
The areas respectively are $6a^2\sqrt{3}$, $4\pi a^2$, $3\pi a^2$.

N.B.—Hence it is seen that circles round a regular hexagon and touching the sides are as 4 : 3.

Also the pupils are familiar with the following names.

Take any two points on the O^{ce} . . . P and Q say

The curved line PQ is called *an arc* of the circle.



PQ may be measured in two ways as indicated by the arrows.

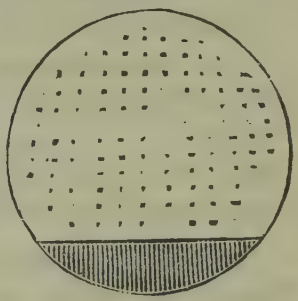
∴ there are two arcs :—

the minor arc PQ.

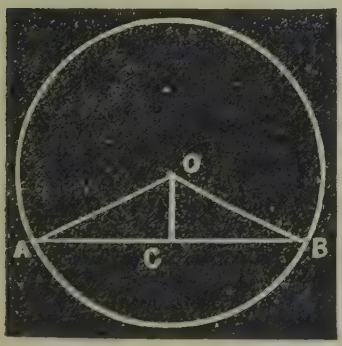
and the major arc PQ.

The straight line joining PQ is called a chord of the circle.

A chord divides a circle into two parts :—each is called a segment. *i.e.*, If two points be taken on the O^{ce} the arc between and the chord joining them form a segment. The smaller segment is called the minor segment and the greater segment is called the major segment *i.e.*, the chord and the minor arc enclose the minor segment, shaded and chord and the major arc enclose the major segment. (dotted).



3. In this article we deal with some important properties of chords.



(**A**) *The chord of a circle.*—Take any two points A and B on the circumference of a circle. The straight line AB is called a chord. Join AB. Also take O the centre of the circle. Join OA, OB. From O, drop a perpendicular OC on AB ; compare △s ACO and BCO. We have ∠ OAC = ∠ OBC for AO = BO and ∠ ACO = ∠ BCO being both right ∠s ∴ the △s ACO and BCO are congruent, *i.e.*, ∠ OAC = ∠ OBC and AC = BC.

i. **The perpendicular from the centre to a chord bisects the chord.**

Also, the student can likewise prove that :—

ii. **The straight line joining the mid-point of a chord to the centre, is perpendicular to the chord.**

iii. The perpendicular bisector of a chord passes through the centre.

These three properties are very important.

(B) (i) The chord AB is $2a$ inches long. The radius of the circle is r in. long. Find the distance of the chord AB from the centre.

In the figure $AC = a$ in., $OA = r$ in. $\Big\}$ $\therefore OC^2 = (r^2 - a^2)$ in. $\therefore OC = \sqrt{r^2 - a^2}$ in.

(ii) In the same circle place another chord = AB. Find its distance from the centre. Deduce the fact that—

iv. Equal chords are equidistant from the centre and the chords which are equidistant from the centre are equal.

4. We solve some problems connected with this important properties of the chord, the arc and segment of the circle—

Example 1 :—An arc of a circle subtends 72° at the centre. The length of the arc is 38·5″. Find the radius of the circle

Suppose the radius is r inches long

Then the $O^{ce} = 2\pi r$.

Arc of sector $= \frac{72}{360} \times 2\pi r$.

$= \frac{1}{5}$ of $2\pi r$.

$\therefore \frac{2\pi r}{5} = 38{\cdot}5$

$\therefore r = \frac{38{\cdot}5 \times 5}{2\pi}$

$= \frac{38{\cdot}5 \times 5}{2} \times \frac{7}{22} = \frac{122{\cdot}5''}{4} = 30{\cdot}625''$ Ans.

Example 2 :— Find the angle at the centre of a circle subtended by an arc 12·5 inches long, if the diameter is 11 in.

whole $O^{ce} = \frac{22}{7} \times 11$ in.

Fraction of arc $= \frac{12{\cdot}5 \times 7}{22 \times 11}$

$$\therefore \text{ angle at centre} = \frac{12{\cdot}5 \times 7 \times 360^\circ}{22 \times 11} = \frac{15750^\circ}{11 \times 11} = \frac{1431{\cdot}8\ldots}{11} = 130.\ 1\ldots\ldots$$

Nr. $= 125 \times 7 \times 36 = 500 \times 7 \times 9 = 31500$

130 degrees nearly.

Example 3 :—A chord 5″ long is at a distance of 6″ from the centre of a circle. Find the radius of the circle.

In the fig. OR = 6″

PR = 2·5″ for PQ = 5″

$\therefore$ PO $= \sqrt{PR^2 + OR^2}$ inches

$= \sqrt{36 + 6\frac{1}{4}}$ inches

$= \sqrt{42\frac{1}{4}}$ inches

$= \frac{13}{2}$″

$= 6{\cdot}5$″

Example 4 :—A chord 6″ long subtends an angle of 120° at the centre. Find the radius of the circle.

AD = 3″

∠AOD = 60.

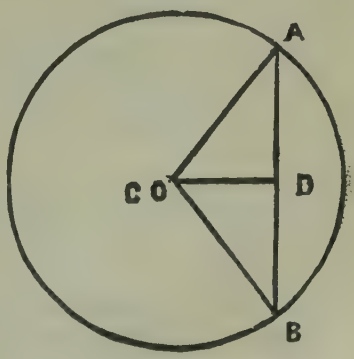
∠ADO = 1rt. ∠

$\therefore$ In the △ AOD

OD $= 3''/\sqrt{3}$ and

OA $= 6/\sqrt{3}$ inches

i.e., $OA = \frac{6\sqrt{3}}{3} = 2\sqrt{3}$

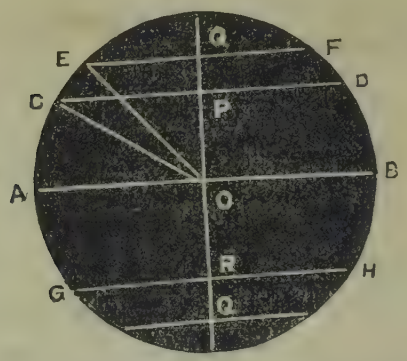


$= 2 \times 1{\cdot}732$″

$= 3{\cdot}464$

$= 3{\cdot}5$″ nearly.

Example. (4) Two chords are parallel to each other and are placed in a circle whose radius is 6 cms. The length of the longer chord is 4·8 cms. and that of the shorter is



3·6 cms. Find the distance between them. How will you geometrically place the two chords in the circle?

The distance of EF (3·6 in.) from O is $\sqrt{6^2-1{\cdot}8^2}$ cms.

CD = (4·8in.) from O is $\sqrt{6^2-2{\cdot}4^2}$ cms.

i.e. $OQ=\sqrt{(6+1{\cdot}8)\,(6-1{\cdot}8)}$ cms. $=\sqrt{7{\cdot}8\times4{\cdot}2}$ cms.

$=6\sqrt{1{\cdot}3\times{\cdot}7}$ cms. $=6\sqrt{{\cdot}91}$ cms.

$OP=\sqrt{(6+2{\cdot}4)\,(6-2{\cdot}4)}$ cms. $=\sqrt{8{\cdot}4\times3{\cdot}6}$ cms.

$=12\sqrt{7\times{\cdot}3}=12\sqrt{{\cdot}21}$ cms.

$\therefore PQ=OP-OQ=6\sqrt{{\cdot}91}-12\sqrt{{\cdot}21}$ cms.

$={\cdot}6\sqrt{91}-1{\cdot}2\sqrt{21}$ cm.

$={\cdot}6\times9{\cdot}54-1{\cdot}2\times4{\cdot}58$ cm.

$=5{\cdot}724-5{\cdot}496$ cm.

$=5{\cdot}72-5{\cdot}5$ cm.

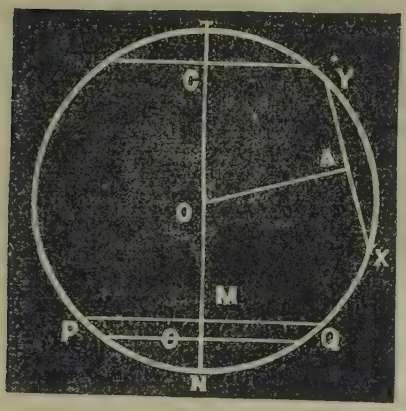
$={\cdot}22$ cm.

```
                    9·54
              91  | 953
              81  |
          185 |1000
              | 925
         1903 |  7500
                5709
         1906 | 179 100
                  458
```

The figures are only rough figures drawn for purposes of calculation only.

```
          21 | 458
          16 |
       85|500
         |425
     908 |7500
         |7264
     916 |23600
```

The student should note that the distance may also be



OP+OR=11·22 cms. for, the chord at a distance=OP, on the other side of AB must be equal to CD. In the figure the chord GRH=CD for, OR is cut off=OP.

To place two parallel chords of given lengths in a circle.

One of the chords is easily placed.

The other chord must be parallel to this and must have a given length. Place the second chord anywhere in the circle. Drop a perpendicular on this chord from the centre. Take the dividers and measure the distance.....(I).

Draw the perpendicular bisector of the first chord. Produce it to meet the circumference on either side. From the centre cut off distances on either side of this perpendicular bisector equal to the distance (I) we have already taken. Chords drawn parallel to the first chord through these two points will be equal to the second chord.

Let O be the centre of the given circle and AB and CD—two lengths. It is required to place in the circle two chords parallel to one another and equal respectively to AB and CD.

Take the length BA. Take P in the O^{ce} and cut off PQ=AB. From O the centre draw OM perp^{r}. to PQ to meet the O^{ce} at points N and T.

Place another chord XY=CD anywhere in the circle; OA is its distance from the centre. Cut off OB and OC in TN.

Draw ||^{s} to PQ through B and C. These two chords will be the chords required.

5. The following points must be noted.

(i) *The nearer the chord to the centre the longer it is.*

(ii) *The farther the chord from the centre the shorter it is.*

(iii) *The greatest chord of a circle is the diameter.*

(B) The perpendicular bisector of a chord passes through the centre. Hence,

(i) *Find the centre of a circle, a portion of the circumference i.e., an arc being given.*

(ii) *Which is the same thing as describing a circle through three given points.*

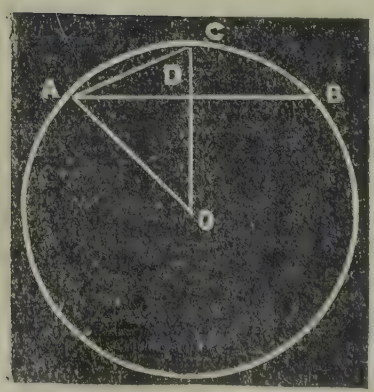
(iii) *Which again is the same thing as describing a circle round a triangle i.e., drawing the circum-circle of a* $\triangle$.

(C) (i) The length of the chord AB of an arc ACB is given $= 2a$. The perpendicular bisector of the chord meets the circle in C, **CD is called the height of the segment.** this height is also given (say) h, find the radius of the circle.

Suppose the length of the radius is r. CD produced backwards must go through the centre. Suppose O is the centre.

In the $\triangle$ ODA, $\angle$ODA is a right. $\angle$

$$OD = r - h.$$
$$OA = r.$$
$$\therefore \text{ we have } r^2 = a^2 + (r-h)^2$$
$$i.e.\ r^2 - (r-h)^2 = a^2$$
$$i.e.\ h\,(2r-h) = a^2.$$
$$i.e.\ 2r - h = \frac{a^2}{h}$$
$$i.e.\ 2r = \frac{a^2}{h} + h$$
$$r = \tfrac{1}{2}\left(\frac{a^2+h^2}{h}\right)$$



(ii) Given radius r and height of segment h. Find the length of the chord.

$$r^2 - (r-h)^2 = a^2$$
$$\therefore a = \sqrt{h(2r-h)}$$

(iii) Given a and r find h *i.e.*, given the length of the chord and the radius, find height.

$$(r^2 - a^2) = (r-h)^2$$
$$\therefore r - h = \sqrt{r^2 - a^2}$$

$$h = r - \sqrt{r^2 - a^2}$$

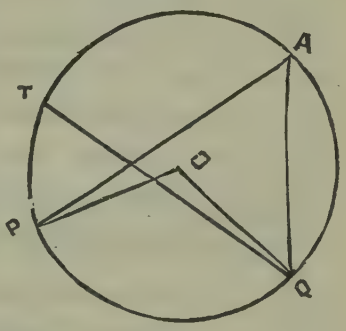
(iv) (*a*) Given length of chord and the height, find chord of half the arc cut off by the chord. From (iii) supra $h = r - \sqrt{r^2 - a^2}$

$$\therefore \text{AC} = \sqrt{a^2 + \{r^2 - \sqrt{r^2 - a^2}\}^2}$$
$$= \sqrt{a^2 + r^2 + r^2 - a^2 - 2r^2 \sqrt{r^2 - a^2}}$$
$$= \sqrt{2r^2 - 2r^2 \sqrt{r^2 - a^2}}$$
$$= \sqrt{2r\,(r - \sqrt{r^2 - a^2})}$$

6. A. If any two points P and Q be taken on the O^ce of a circle and any other point A also taken, then we have

∠ PAQ which is called angle in the segment PAQ.

If any point in the O^ce. of a segment be joined to the ends of a chord or an arc, the angle formed at the point is called **the angle in the segment.**



This angle is also said to be subtended at the O^ce by the chord or arc P Q. This angle is also called **angle at the O^ce.**

Similary if P and Q be joined to the centre ∠POQ is called the angle at the centre. The following geometrical truths must be known to the students.

(a) The angle subtended by an arc of a circle at the centre, is double the angle subtended by the same arc at the O^ce.

hence

(b) i. **Angles in the same segment of a circle are equal, and**

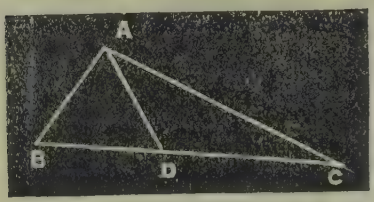
ii. **the angle in a semi-circle is a right angle,**

i.e., in the figure ∠POQ is 2 ∠PAQ or ∠PTQ.

∠PAQ = ∠ PTQ etc.

B. (*a*) ABC is a △ right. angled at A. If AD be drawn such that ∠BAD = ∠ ABD, prove that BD = DA = CD.

N.B.—A circle with centre D and radius BD will pass through B, A and C.



(*b*) If in any triangle ABC, the longest side being BC, the join DA of the mid-point to the opposite vertex be equal to half the longest side, then A is a right. angle.

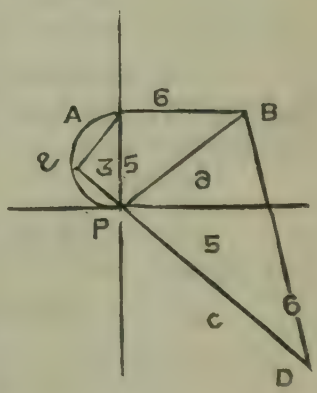
Proof: DA = DB; hence $\angle DAB = \angle DBA$.
Also DA = DC; $\angle DAC = \angle DCA$.
$\therefore \angle BAC = \angle^s$ ABC and ACB; but the three angles are together equal to two rt. angles.
$\therefore \angle BAC$ is a right angle.

N.B.—The property that the angle in a semi-circle is a right angle must be inferred; also vide BK II art 102 P. 312.

i.e., The angle at the circumference subtended by a diameter is equal to one right angle.

Hence, The circle round A, B and C has the middle point of the hypotenuse for its centre.

7. In this article some typical problems chosen from the S. S. L. C. Public Examination papers are solved.



Example 1.—A village postman attached to the Post Office at *P* has to go to five villages *A*, *B*, *C*, *D* and *E*, and return to *P*. *A* is 5 miles due north of *P*. *B*, *C* and *D* are on the eastern side of the road from *P* to *A*; *B* is 8 miles from *P* and 6 miles from from *A*; *C* and *D* are 5 and 6 miles respectively from *P* on a straight road *PCD* which is at right angles to *PB*. *E* is 3 miles from *P*, its position being to the west of the road *PA*, and the roads *PE* and *AE* being at right angles to each other. Draw a diagram [scale. 1 cm. = 1 mile] and indicate the shortest route for the postman. What is the length of his circuit?

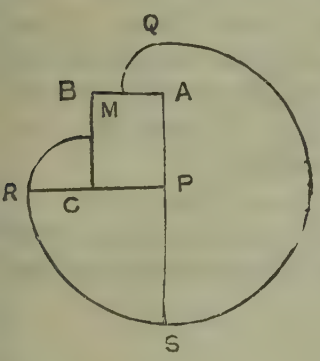
The shortest route is evidently
P E A B D C P or
P C D B A E P

Distance :—

P E ...	...	...	3 miles given
E A $=\sqrt{5^2-3^2}$	...	...	4 ,,
A B = ...	...	...	6 ,,
B D $=\sqrt{PB^2+PD^2}=\sqrt{64+36}=$	...		10 ,,
D C P = ...	...	...	6 ,,
Complete Circuit	...	= ...	29 miles

E is determined by drawing a semi-circle on PA as diameter and cutting off PE = 3.

2. In a certain meadow there is a hut whose ground-plan is a square, each side of which is 28 ft. A cow is tethered to a post at one of its corners by a rope 35 ft. long. Find the area that the cow has for grazing.



P is the post; PQ, PR and PS are each 35 ft. long. When the cow turns round A, 28 ft. of the rope will be held at the corner and it can move about the quadrant AQM. Similarly when rounding the corner at C.

Hence entire area it can graze through is $\frac{3}{4}$ of circle of radius 35 ft. $+\frac{1}{2}$ of circle of radius 7 ft.

$$=\frac{3}{2}\times 11\times 5\times 35+\tfrac{1}{2}\times\frac{22}{7}\times 7\times 7$$
$$=2964{\cdot}5 \text{ sq. ft.}$$

3. A circular arch over a river rises 4 ft. at its highest point above the level of the tops of the vertical piers. If the distance between the piers is 28 ft., find graphically or otherwise, the radius of the circle of which the arch forms a part.

Let O be the centre of the circle.

Then OP = OQ. If OQ = r., OM = r—4.

In the rt. ∠d △. OQM.

$$\left.\begin{array}{ll} OQ = & r \\ OM = & r-4 \\ QM = & 14 \end{array}\right\}$$ Hence

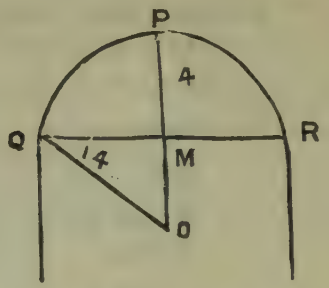
$r^2-(r-4)^2=196.$

$4(2r-4)=196$

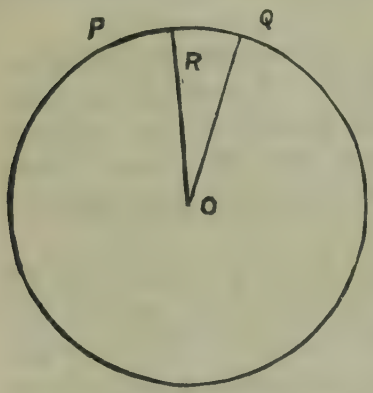
$2r-4=49$

$2r=53$

$r=26\frac{1}{2}.$



(i) The students will note in the figure that a line PQR drawn from P outside the circle cuts the circle in two points Q and R.



The line PQR is called the line cutting the circle or a **secant** to the circle.

(ii) If the line PQR is made to move round P *i.e.*,, if the line PQR assumes the position PQ_1R_1 the students will note in the figure that Q_1 and R_1 approach each other.

Q_2 and R_2 are closer still

Q_3 and R_3 are so close that they cannot be distinguished, so that ultimately Q_3 and R_3 coincide.

In this position PQ_3 is called a tangent.

i.e., **A tangent to a circle is the line that cuts the circle in two points which are coincident.**

or in other words.

A tangent to a circle is a straight line which meets the circle, but when produced does not cut it.

The point where the line **touches** *the circle is called* **the point of contact.**

(iii) Let a line PQ touch a circle at Q.

Join Q to the centre, O.

Note that the angle PQO is rt. $\angle$

This might be deduced or inferred from the fact that the $\perp^r$ to the secant from the centre, is the radius when Q and R coincide.

Hence the fact—**The radius and the tangent at a point are at right angles.**

(iv) To draw a tangent to a circle through a point Q on the O^{ce}. Join the point Q to the centre O.

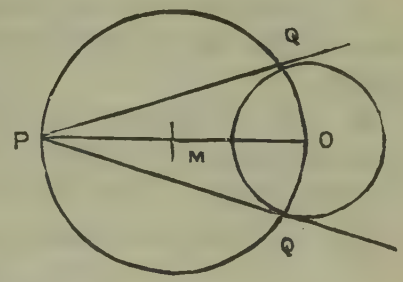
Through Q draw PQ $\perp^{r}$ to QO.
Then PQ will be a tangent.

(v) To draw a tangent to a circle from a point P, outside the circle.

Join P to O the centre.

On PO as diameter describe a circle to cut the given circle in Q and Q^{1}

Then PQ and PQ^{1} will be tangents



(i) Two tangents can be drawn from a point outside the circle.

(ii) These two tangents are of equal length.

N. B.—This construction is also proposed as an exercise.

EXERCISE X-A

Circumference, and area of Circle, annulus, sector and other Properties of Circles

To be done in Form VI.

1. The width of a circular running track is 5 yards and its area 2200 sq. yards. Find the diameter of its inner boundary.

2. A fly-wheel of diameter $10\frac{1}{2}$ in. rotates at 1000 revolutions per minute. Find the speed in miles per hour of a point on its circumference.

3. Find the perimeter and area of a quadrant of a circle of radius 10 cm.

4. It is proposed to add to a square lawn of 58 ft. side, two curved ends, the centre of each circle being the intersection of the diagonals of the square. By how much will the area be increased ?

5. The minute hand of a clock is $10\frac{1}{2}$ inches long. Find the area it covers between 9-50′ and 10-20′ A.M.

6. The diameters of the piston and air-pump of an engine are as 2 : 1·2; find the diameter of the air-pump when the area of the piston is 1134·1 sq. in.

7. A circle is described upon one side of an equilateral triangle of side 4 in. as diameter. Find the area of that part of the triangle, outside the circle.

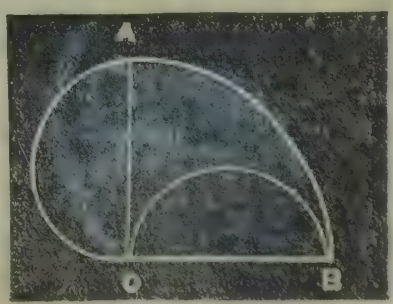
8. Find the area of the segment of a circle of radius 4 cms. cut off by a chord which subtends a right angle at the centre.

9. The lengths of two chords drawn from a point in the circumference of a circle to the extremities of a diameter are 5 and 12 cms. Find the area of the circle.

10. The arc of a sector subtends an angle of 40 degrees at the centre. The perimeter of the sector is 34 cm. Find the radius of the circle and the area of the sector.

11. To make a wooden letter *C*, a circular piece of wood of radius $OA = 1{\cdot}5''$ was taken. The inner circle of radius $OB = 1$ in., was removed and the portion $ABCD$ was also re-moved. $\angle AOD = 60°$. What fraction of the original weight is left?

12. A rectangular piece of paper is $8''$ by $6\frac{1}{2}''$. The corners are rounded off, so that they form quadrants of circles. The st. parts left being $5\frac{1}{2}''$ along the length and $4''$ in the breadth. What fraction of the original sheet is left? Express the fraction in the form $1 : x$ where x is correct to two decimal places.



13. AOB is the quadrant of a circle. Semi-circles are drawn on the radii OA and OB as in

the figure. Find (1) the area of the shaded portion, (2) the ratio of the perimeter of the shaded portion to that of the quadrant AOB. How many figures like the shaded portion can you cut from a circle? Draw a figure to show how you will cut it.

14. In the tabular statement r is radius of circle, $2a$ length of chord and h distance of chord from centre. Find the lengths left blank :—

	r	$2a$	h
(i)	20	?	12
(ii)	25	48	?
(iii)	17·5	21	?
(iv)	22·5	27	?
(v)	?	57	38
(vi)	?	56	21

15. The angle subtended at the centre by an arc 6·16 cms. long is 48°. Find the area of the circle.

16. A chord 8 cms. long subtends an angle of 60° at the centre. Find the length of the major arc cut off by the chord.

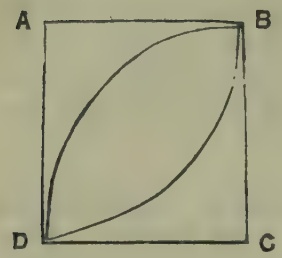
17. An arc of a circle subtends an angle of 40° at the centre. The perimeter of the sector of which the arc forms a part is 17 cms. Find the radius of the circle.

18. A wire 71·4 cms. long is bent into the form of a quadrant of a circle. Calculate the area enclosed by it.

19. Two circles are drawn one to touch the sides and the other round the corners of a square. If the side of a square is 4 cms., find :—

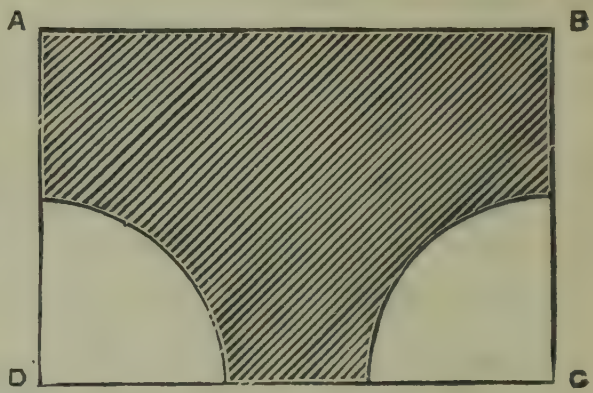
(i) the areas of the two circles separately.

(ii) their ratio.



20. Find the area of the portion contained by the arcs :—The arcs are drawn with centres A and C and radii equal to a side of the square. The side of the square is 7 in.

21. Find the perimeter and area of the shaded portion if 1 inch represents 14 ft.; AB = 2″, BC = 1·5″



22. A pendulum 3 ft. long swings 7·5 degrees on each side of the vertical. Find the distance through which the lower end moves in a single swing.

23. A railway curve is part of a circle and is $1\frac{1}{2}$ miles. If the angle it subtends at the centre is 30°, what is the radius of the curve in yards ?

EXERCISE X-B

1. (*a*) AB is a chord of a circle 3·2 cms. long. If its distance from the centre O of the circle be 1·2 cms., draw the circle and find its radius.

(*b*) The chord AB of a circle is 3·4 cms. long and the height of the arc AB = 1 cm. Draw the arc in position and find the radius of the circle of which the arc forms a part.

2. (*a*) Draw a circle of diameter 3 inches and place in it two parallel chords of length 2″ each. Measure the distance between their mid-points.

(*b*) In a circle of radius 1·6″ draw 2 parallel chords 2·4″ and 2″ in length, such that the centre lies between them. Measure the distance between the chords.

(*c*) If the chords be on the same side of the centre, what is the distance between them?

3. (*a*) Draw a circle whose radius is $(\sqrt{5}-1)$ inches.

(*b*) Describe an equilateral triangle in it. Measure the length of a side.

4. Out of a circular disc of metal 35 equal circular holes are punched; the weight of the metal thus punched out is to the weight of the perforated disc as 45 : 67; compare the diameters of the disc and of the holes.

5. The range of a gun is $3\frac{1}{2}$ miles. It is stationed at a place $1\frac{1}{2}$ miles from a straight road. What length of the road can it command? If a furlong more of the road has to be guarded, find from a diagram, the least distance the gun should be brought nearer to the road.

6. A small canal 12 ft. broad is to be spanned by a bridge with a circular arch resting on two piers each 8 feet high. If the greatest height of the bridge be 12 ft., represent in a diagram the section of the arch, and find the radius of the circle of which the arc forms a part.

7. (*a*) An arch like the minor arc of a circle 8 ft. in diameter is built over two pillars 6 ft. apart. Find by means of a diagram drawn to scale the height of the arch.

(*b*) Draw a circle of radius 3·6 cms. and place in it a chord 4·2 cms. in length. Find its distance from the centre. Also find the heights of the major and minor segments. Verify your results by calculation.

8. (*a*) A chord of a circle subtends an angle of 60 degrees at the centre. If the chord is 10 cms. long, find the areas of the two segments into which the chord divides the circle.

(*b*) From a point on the circumference of a circle two chords are drawn at right angles and their lengths are 1·2″ and 1·6″. Find the area of the circle and draw the circle with the chords.

9. A barn is a square of 40 ft. side. At one corner a cow is tied by a rope 60 ft. long. Making all possible calculations and taking necessary measurements, find the area the cow can graze through.

10. The chord forming the base of a segment of a circle is $2''$ in length and subtends an angle of 60° at the centre. Find the area of the smaller segment cut off by the chord to the nearest tenth of a sq. in. If the chord subtends (1) a rt. angle, (2) an angle of 120° at the centre, find to the nearest tenth of a sq. in. the area of the minor segment formed.

11. Draw a circle whose radius is an inch. Place a chord one inch long in the circle. On this chord and on side remote from the major segment, describe an isosceles triangle whose height is 4 inches. Find the area enclosed by the major segment and the sides of the isosceles triangle.

12. A process-server had to go to four places B, C, D and E from A; B is 10 miles due east of A; C, D are such that CA, DB, CD are all equal, and E is 3 miles from C, and angle CDE is a rt. angle. Find the distance of the shortest route he had to go through and draw a figure to scale.

13. The side of a square is 12 in.; find the area included between the square and the circumscribed circle.

14. An equilateral triangle inscribed in a circle has an area equal to $144\sqrt{3}$. What is the area of the circle?

15. A window is in the form of a rectangle 2 feet wide, surmounted by a circular arc (less than a semicircle) of radius 3 feet. The height of the window from the base to the highest point of the circular arc is 4 feet. Determine the height of the rectangle.

16. (*a*) Describe a circle of 3 cms. radius. Draw AB and produce it to D such that the tangent from D to the circle may be $3\sqrt{3}$cms. Do the whole construction and shew that two such tangents can be drawn. AB is a diameter.

(*b*) If DP and DQ be the tangents each of $3\sqrt{3}$ cms. find correct to the nearest centimetre, by calculation, the area of the figure formed by the tangents and the arc PQ.

17. (*a*) Draw a circle with centre O and radius 2 cms. From any point A on the circumference draw a straight line AM at right angles to the radius OA. What is AM in relation to the circle?

(*b*) Show how a tangent can be drawn from any point on the circumference of a circle. A is a point on the circumference of a circle with centre O and radius 2·4 cms. If the length of the tangent AM from A be 1·8 cms. find OM.

(*c*) O is the centre of a circle of radius 4 cms. A and B are two points on the circumference $2\frac{1}{2}$ cms. apart. Draw tangents through A and B and measure the distance between the centre of the circle and the point of intersection of the tangents.

18. (*a*) Describe a circle with centre A and radius 2·6 cms. Take any point B, 4 cms. from A and on AB as diameter draw a circle cutting the first circle in C and D. Show that BC and BD are tangents to the first circle.

(*b*) Hence deduce a method for drawing a tangent to a circle from any point outside it.

19. ABCDE represents the section of a gothic archway leading to a lecture hall. If AB = 6 ft. AE = ED = DA = 4 ft., find (1) the area of the archway, and (2) the cost of planks required to fit it up with doors at 12as. per sq. foot. The arcs AE and DE are drawn with centres D and A respectively. E is the top-most point where the arcs meet.

20. The ends of a diameter of a sphere as centres, two circular caps are cut off, to make a paper weight. If the diameter be 3 in. and the radius of each circle at the ends 1 in., find the distance between the centres of the circles, *i.e.*, find the height of the weight.

21. A sphere of diameter 3 in. rests on a hollow cylinder placed on a table. The diameter of the cylinder is 2·8 in. Find the height of the centre of the sphere above the table. Height of the cylinder is 8 inches.

22. Two parallel chords AB, XY, 1·8 and 2·4 respectively are placed in a circle whose diameter is 3·1 in. Find the area of the trapezium ABXY.

23. A hollow cylinder of height 8 inches and internal diameter 6 inches is placed on a table. A sphere of diameter 10 inches is placed to rest on the cylinder so that part of the sphere is within the cylinder. Find at what height the centre of the sphere is vertically above the table.

EXERCISE XI

Pythagoras Theorem

Many types have already been given in Book II and choice questions may also be selected from Part II of this work.

1. A flagstaff is 36 ft. high. There are three stay ropes run from the top of the pole to points which are 27, 15 and 10 ft. respectively from the foot. Find the total length of these, supposing the ropes are taut.

2. Plot the two points $(-4,-5)$ and $(-9,-17)$. If the former is the centre of a circle and the latter is a point on the circumference, find the radius of the circle. Scale $\frac{1}{10}'' = 1$ unit.

3. The foot of a ladder is 8 ft. from the foot of a vertical wall and the top rests against a point 12 ft. vertically above the foot. If it be so lowered that the foot is at a point 6 ft. farther from the wall, by how much to the nearest tenth of a foot would the top be lowered ?

4. Three posts A, B & C are respectively 25, 10 and 22 ft. above the ground in a straight line. The distance from A to B is 8 ft. and from B to C is 9 ft. along the feet. Find both from a figure and by calculation the length from A to B and from B to C as measured from top to top of each ?

5. A very small ring is fixed 8 ft. above a horizontal floor. A and B are points on the floor 6 ft. and 15 ft. from the point where the ring would strike if it fell vertically down. Calculate the length of a tight string which passes through the ring and has its ends at A and B.

6. Two boys are 56 yards apart. One of them is flying a kite, which is directly over the head of the other. 119 yards of string are let out. Supposing the string is straight, what would be the height of the kite ?

7. A rectangular prism whose height is 7 cms. has a square base whose side is 8 cms. Determine the distance of the centre of the base from a corner of the prism which is not on the base.

8. ABC is a straight line AB = 3 ft, BC = 12 ft. BD is drawn through B perpendicular to AC and = 6 ft. Calculate the areas of the squares on DA, DC; use your results to show that ∠ADC is a right angle.

9. The angle of elevation of the top of a tower is 30°. Going 50 ft. nearer the tower along the line joining the 1st position and the foot of the tower, the angle of elevation of the same top is 45°. Find the height of the tower correct to the nearest foot.

10. A square garden is $2\frac{1}{2}$ acres in extent. Find the cost of constructing pathways from the centre to the corners at Rs. 0-5-0 per hundred feet.

11. ABCD is a rectangular enclosure with green live fence all round, length being 40 yards and breadth 16 yards. A goat is tied by a rope at the corner B and it can just reach E the mid point of AB. What length of the fence CD can it nibble?

12. From the masthead of a ship the angle of depression of a boat in the sea is 60°. From the deck of the ship the angle of depression of the same boat is 30°. If the mast is 60 ft. high, how far is the boat from the ship along the surface of the sea?

EXERCISE XII—A

Areas and Volumes

For revision work in Form V or VI.

1. A cylinder of brass of diameter 3·2 cm. and height 1·4 cm. weighs 98·53 gr. Find in grammes the weight of a cubic centimeter of brass.

2. The weight of a franc is 5 grammes. It is $1\frac{3}{4}$ cm. across and 2 mm. thick. Find the weight of a c.c. of the metal.

3. The area of a triangle is equal to the area of a trapezium and their heights are also equal. What is the

relation between the base of the triangle t and a and b the parallel sides of the trapezium ?

4. A room is 30 ft. long, 24 ft. wide and 20 ft. high. Find
(i) the diagonal of the room.
(ii) the number of people it can accommodate if each individual requires 200 c. ft. of air space every hour and has to remain in the room for 2 hours ?

5. The rain-water on an asphalt tennis-court drains into a circular reservoir 14 ft. across. If the asphalt court is 63 yds. by 44 yds, what height will the water in the reservoir rise for every inch of rain ?

6. A tank is made of slate one inch thick. It is open at the top. The length, breadth and depth externally are 3ft. 6 in., 2ft, 9 in. and 2ft. 1 in. respectively. If slate weighs 130 lbs. per c. ft., what is its weight ?

7. The weight of a piece of square card-board is 225 grs. If a sq. in. of the card-board weighs 4 grs., find the side of the piece.

8. The length, breadth and height of a covered box (outside measurements) are in the proportion 5 : 4 : 3. If the length and breadth together are 72 inches and the wood is half an inch thick, what is the cubical capacity of the box ?

9. A triangular piece of wood is cut from a plank $\frac{1}{2}''$ thick, its weight 2lbs. 12 oz. and one of its sides is 2 ft. 3 in. long ; what is the corresponding height ? A cub. ft. of the wood weighs 58 lbs.

10. A rectangular sheet of paper 8·8″ long and 4·2″ is rolled into a cylinder of height 4·2″. Find its volume.

11. The volume of a cylinder is 140 c. in. and its height is 15·4 inches. Find the radius of the base.

12. A glass trough open at the top and sides and bottom $\frac{1}{2}''$ thick is 13″ long, 7″ broad and $4\frac{1}{2}''$ high externally. This contains mercury flush with the top. Find its weight given that 1 c. ft of water weighs 1000 ozs. and mercury is 13·6 times as heavy as water.

13. A rectangular granary open at the top is enclosed by walls $1\frac{1}{2}$ ft. thick, 40 ft. long, 18 ft. broad and 20 ft. high

internally. Find the number of cart loads of bricks required for the walls if each brick is 8″ by 5″ by $1\frac{1}{2}$″ and a cart load contains 500 bricks.

14. If the contents of a granary cylindrical in shape 8ft. across at the base and $10\frac{1}{2}$ft. high be transferred to a rectangular one 8ft. by 4ft.. how high will it stand there ?

15. A child carries mud in a cylindrical can 4″ across and $3\frac{1}{2}$″ high. How many cans must the child carry to fill a tub also cylindrical in shape 9″ across and 7″ high.

16. Water rushes into a lake through a circular orifice 3ft. across at a speed of 14 mls. an hour. How long will it take to raise the level of water in the tank by 3ft. the tank being a square of $1\frac{1}{2}$ furlongs side ?

17. A hose pipe is 2″ across and patrol rushes through it at the rate of 2·8 miles per hour. How many minutes will it take to fill the reservoir of a motor cylindrical in shape 1ft. across and 2·8ft. long.

18. A stout pencil 7·7″ long is 3″ across. The graphite in the centre is a square side of 1″. Find the volume of wood in the pencil.

19. A tin can for drinking water is 4·2″ high and 2·6″ across. Water is stored in a cylindrical drum 14·4″ across and 16·8″ high. How many cans are there in the drum ? Supposing that each boy requires $2\frac{1}{2}$ cans per day, how many such drums must be kept ready in a school of 400 boys ?

20. The volume of a rectangular prism is 14·415 c. cms. The length of one side is 3·1 cms. If the length of one of the other sides is 3 times this length, how long is the remaining side ?

21. Find the volume of wood required for a box with a lid 11″ long, $4\frac{1}{2}$″ wide and $6\frac{1}{4}$″ deep, the thickness of the plank being $\frac{1}{2}$″.

22. In a rectangular piece of level ground 200 feet long and 120 feet broad, a rectangular bath 170 ft. by 90 ft. is dug The earth removed is evenly spread out on the remaining ground and it is found that tne level of the ground is thereby raised by 6 feet. What is the depth of the bath ?

23. A water-tank has vertical sides and the top is a square. A scale up one side shows the amount of water in the tank in thousands of gallons. These marks are $8\frac{1}{3}$ inches apart. Calculate the length of a side of the tank correct to the nearest foot. 1 cub. ft. contains 6.2 gallons.

24. Beyond one end of a tennis court, a wall has to be raised. It is to be 45 ft. long and 10 ft. high. The bottom is 30 in. thick and the top is 10 in. thick. The interior surface of the wall is vertical and the back slopes uniformly to the vertical. Draw to scale the end-view of the wall, find the cost of raising that at Rs. 0-5-0 per cub. ft.

25. The capacity of a double bullock bandy is 8 ft. by $1\frac{1}{2}$ ft. by $1\frac{1}{2}$ ft.; 180 tons of gravel have to be carried to a roadside from a quarry. 10 bandies are engaged How many trips must each make to bring in the gravel from the quarry, supposing that all make an equal number of trips and that 20 cub. ft. weigh a ton?

26. A town has a population of 400,000 and a water supply of 30 gallons per head per day, is required. A reservoir is provided to hold supply for 6 months of 184 days with a mean depth of 20 feet. What must, in acres, the area of the reservoir be? Also find the area in sq. miles of the catchment basin if 20 inches of rainfall in the year will yield sufficient water to supply the town. ($6\frac{1}{4}$ gallons = 1 c. ft.)

27. A piece of timber $7\frac{1}{2}$ in. wide, 5ft. 3 in. long and 0·389 of an inch thick, has its thickness reduced to $\frac{3}{8}$ in. by the removal of eight uniform shavings of equal thickness. What decimal of a cub. in. of wood is there in each shaving correct to two decimal places?

EXERCISE XII-B

Solids—Prisms.—*(Continued)*

1. A stack of 125,000 bricks closely packed up is 41 ft. 8 in. long, 16 ft. 8 in wide and 14 ft. 7 in. high. If each brick is 10 in. long and $3\frac{1}{2}$ in. thick, find its breadth.

2. An open tank measuring on the outside 6 yds.-2 ft. in length, 3 yds.-2 ft. in width and 7ft. deep, is made with sides and floor of brick 1 ft. thick and is filled with water. Find the weight of the tank and its contents, it being given that 1 c. ft. of water weighs 1000 oz. and that brick is $1\frac{1}{2}$ times as heavy as water.

3. A river with vertical sides is 30 feet deep and 200 yards wide and flows at 4 miles an hour. How many tons fall into the sea every minute?

4. A *rod* of brickwork is $272\frac{1}{4}$ sq. ft. of brickwork, $13\frac{1}{2}$ inches thick and the contract rate in England for a *rod* of brickwork is £ 22. Find the cost of building a wall 54 yds. long., 7 ft. 4 in. high and 9 in. thick.

5. What must be the dimensions of a rectangular cistern, of which the base is square, and the depth equal to a quarter of a side of the base, in order that it may contain 19,321 gallons of water, each gallon containing 278 cub. in?

6. The water supply of a district containing 750,000 inhabitants is drawn from a lake whose area is 10,000 acres. Allowing 26 gallons per day for each person, find how many days' supply is represented by a depth of 1 ft. of water in the lake, taking a gallon to contain 277 cub. in.

7. If 6 bars of iron, each 4 ft. long, 3 inches broad and 2 inches thick weigh 288 lbs., how much will 15 weigh each $6\frac{1}{2}$ ft. long, 4 inches broad and 3 inches thick? How many of the latter bars would be equal in weight to 26 bars of the former?

8. A rectangular field is 300 yds. by 200 yds. A moat, 5 yds. wide and 6 yds. deep is dug round it, on the outside, and the earth is evenly spread over the field. Find by how much the level of the field is raised.

9. An empty tank 40 cms. long, 30 cms. wide and 25 cms. high, was filled with water from a tank a metre long and 60 cms. wide. If after filling the smaller the depth of water in the larger is 35 cms., what was the depth of water in the larger originally ?

10. The internal dimensions of a safe are 30 cm., 30 cm. and 23 cm. and it is made of steel 1 cm. thick. Find the volume of the steel and its weight, assuming that steel is 8 times as heavy as water.

11. A cylindrical jar of cross-section 200 sq. cm. holds 10 litres of water. Find how much the level of the water will be raised if a heavy cube of edge 10 cm. is placed in the water.

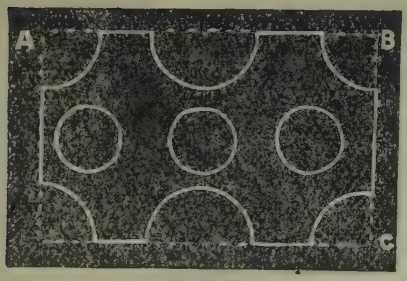
12. A rainfall of 1 in. means that practically 100 tons of water fall on an acre of ground. Given that a gallon contains 277 cub. in. find approximately the weight of a pint of rain-water correct to the hundredth of a pound. 1 gallon = 8 pints.

13. A closed rectangular tank 4 feet long, $2\frac{3}{4}$ feet wide contains $1\frac{1}{4}$ tons of water. When the water freezes, the tank just bursts. If water increases 10% in volume when it freezes, find the depth of the tank. (1 cub. ft. of water weighs 1000 oz.)

14. The front view of a hall is a rectangle 12 ft. by 12 ft. with an arc on one side, the arc showing the arched roof. The centre of the arc is the mid-point of the squire. Find how many people it can safely accomodate if each person requires 210 c. ft. of air-space. The length of the hall = 60 ft.

15. A steel weight originally rectangular was made to assume a shape shewn in the diagramby cutting out four equal semi-circular grooves. The length A to B is 3″ and from B to C is 2″. The thickness is half an inch. E to F is 1″ across. Find its weight if 1 cub. in. of steel weighs 0·29 lb.

16. A parapet wall above a terrace consists of 6 such portions as shewn in the diagram. The length AB is 6 ft. and the height BC is 4 ft. The corner grooves are quadrants and the central grooves are semi-circles, each of radius 1 ft. Three holes are also made along the length, of diameter 1 ft. Find the volume of concrete required for the six portions if the thickness be 1 ft.



EXERCISE XII-C

Cylinders.—(*Continued*)

1. From a log of wood 12 ft. long, twenty-five planks are obtained, each being 12 ft. by 7 in. by $1\frac{1}{2}''$. Assuming that the log is a uniform cylinder of diameter $21''$, what fraction of the wood is wasted?

2. A piece of paper $13{\cdot}2''$ wide and $18{\cdot}7''$ long is rolled into a cylinder with the shorter ends just meeting. What is the diameter of the cylinder? Find the volume.

3. A rectangular box is 12 ft. long, 4 ft. broad and 3ft. high. Twelve cylindrical hot-water tubes run along the length, each $31\frac{1}{2}$ in. in diameter. Find the volume left in the box.

4. One pound of tobacco is packed in a cylindrical tin of diameter 4 in. and height 8 in. What should be the height of a tin of diameter 3 in. which would hold $\frac{1}{4}$ lb. of tobacco similarly packed?

5. Water flows into a bath through two $3\frac{1}{2}$ inch pipes at 5 ft. per second. The bath is 50 ft. long, 24 ft. wide. How long will it take to fill it to a depth of 8 ft?

6. A tub of concrete is internally 2 ft. in diameter and $3\frac{1}{2}$ ft. high. A cylindrical bucket is internally 9 inches broad and $10\frac{1}{2}$ inches high. How many buckets of water will the tub hold?

7. To find the diameter of a uniform tubing, mercury is let into it. The length of the thread is 12·4 cm. The weight of the mercury let in is 267·3 gr. Given that 1 cub. cm. of mercury weighs 13·6 gr. find the diameter of the bore.

8. A steel weight is $6'' \times 5'' \times 4''$ and steel weighs 0·29 lb. per cub. in. If it must weigh exactly two stones, what should be the height of a cylindrical cavity $3\frac{1}{2}$ inches across bored perpendicular to a face?

9. I wish to reduce the weight of a cylindrical bar of 7 cm. diameter by 20 per cent. If this is to be done by turning it down in a lathe, what must its new diameter be?

10. A hollow lead pipe has length 6 yards, external diameter 1 inch and internal diameter $\frac{3}{4}$ inch. If this pipe is recast into a solid cylinder of diameter $1\frac{1}{4}$ inches, find its length in feet.

11. The rain from a certain roof, whose area is 720 sq. feet, falls into a gutter 50 feet long whose cross-section is semi-circular in shape and of diameter $5\frac{1}{2}$ inches. If the gutter were blocked at the outlet, calculate how much rainfall will make it overflow. The answer must be in inches correct to 2 significant figures.

12. Two boys are asked to make each a cylinder of a certain material and of a given weight. One of them produces a cylinder of diameter 9 cms. and 8 cms. high, the other a cylinder of diameter 8 cms. and 7·5 cms. high. If the larger cylinder is 20% too heavy, by how much per cent is the smaller one too light?

On Cones

1. (i) The students have studied in Book II that a rectangle can be folded, to form a cylinder; the length or the breadth being wound to form a circle. This can be very easily seen by boys. The circumference of the circle is either the length or the breadth. The area of the sheet is the curved surface of the cylinder. (Vide Part II P. 382, Art 118.)

(ii) Similarly instead of a rectangular sheet, take a sector of a circle. Fold it so that the bounding arc becomes a circle and the radii coincide. The shape is that of a *cone*. It is called a right circular cone.

It will be seen therefore that

(*a*) the base of the cone is a circle. The length of the arc of the sector is the circumference. The diameter and hence the area of the base can be easily calculated.

(*b*) The radius of the sector is the slant height of the cone.

(*c*) The height of the cone is a side of a rt. ∠d. △ whose hypotenuse = slant height = the radius of the sector and whose another side is the radius of the base.

Also the generation of a cone by the rotation of a rt. ∠d. △ about a side and that of a cylinder .....rectangle.....may be exhibited.

Some examples of the most rudimentary type are solved below :—

Ex. 1 :—An arc of a circle subtends a rt. ∠ at the centre and its length is 18·7 cms. If it be folded into a cone find :—

(i) the height of the cone.

(ii) the curved surface of the cone.

Solution. The length of the arc = 18·7 cms.

∴ The length of the whole O^{ce} = 74·8 cms.

$\therefore$ The diameter of the circle $= \frac{74{\cdot}8 \times 7}{22}$ cms.

$= 23{\cdot}8$

The radius $= 11{\cdot}9$ cms.

This is the slant height.

$\therefore$ Area of sector $= \frac{1}{4} \times \frac{22}{7} \times 11{\cdot}9 \times 11{\cdot}9.$

$= 111{\cdot}3$ Sq. cms.

which = the curved surface of cone.

The arc becomes a circle.

O^{ce} of circular base $= 18{\cdot}7$ cms.

$\therefore$ radius of base $= \frac{18{\cdot}7 \times 7}{22 \times 2}$ cms.

$= \frac{11{\cdot}9}{4}$ cms.

$\therefore$ ht $= \frac{11{\cdot}9}{4}\sqrt{15} = 11{\cdot}5$ cms. nearly.

Ex. 2 :—If 6 conical vessels each ·7ft. high and 12·6 in. across at the base have to be made, find the area of tin-sheeting required.

The circumference of the base $= \frac{22}{7} \times 12{\cdot}6''$

The slant height $= \sqrt{8{\cdot}4^2 + 6{\cdot}3^2} = 10{\cdot}5$

$\therefore$ The area of the sector $= \frac{1}{2} \times \frac{22}{7} \times 12{\cdot}6 \times 10{\cdot}5.$

$= 11 \times 12{\cdot}6 \times 1{\cdot}5.$

$= 207{\cdot}9. = 208$ Sq. in Ans.

2. (i) In a cone the vertical height, the slant height and the radius of the base form a rt. angled triangle.

$\therefore$ denoting them respectively by h, l and r.

we have the relation :— $l^2 = r^2 + h^2$

(ii) It must also be remembered that l is the radius of the original sector

r is the radius of the circle when the arc of the sector is folded into a circle.

3. The following experiments can easily be made in a laboratory.

(i) Take a cylindrical beaker of thin glass and also a conical funnel whose circular base = the circular base of the cylinder and of the same vertical height. Fill the funnel with water. How many funnel fulls can the cylinder hold ?

(ii) Circular bases equal and heights equal—make a solid cone and a solid cylinder of clay ; weigh them both ; compare the weights.

In each case the pupils will see that the volume of the cylinder is 3 times that of the cone.

(iii) What will happen if a cone is inverted into a cylinder of equal height and equal base and the cylinder then filled with water up to the brim ; on removing the cone, the height of water = $\frac{2}{3}$ the height of the cylinder.

Therefore it is easily seen that if h be the height and r the radius of the base of both the cylinder and the cone.

the volume of the cylinder $= \pi r^2 h$.
and the volume of the cone $= \frac{1}{3} \pi r^2 h$.

(iv) Given the radius of the base r and the height h.

the slant height $= \sqrt{r^2 + h^2}$
the volume $= \frac{1}{3} \pi r^2 h$

the circumference of the base $= 2\pi r$ and this is the arc of the sector ; hence, the curved surface of the cone $= \frac{1}{2} \cdot 2\pi r \cdot \sqrt{r^2 + h^2} = \pi r \sqrt{r^2 + h^2}$.

(v) It will be remembered by pupils that when

Curved surface is required ; area of sector must be found out and this again is either fraction of a circle or is calculated with slant height and O^{ce} of base.

$\frac{1}{2} l \times$ O^{ce} of base.

Vide also Exercise V for list of formulae.

4. In this article we solve some typical problems on cones taken from the S.S.L.C. Public Examination Papers.

Example 1: A certain boy took a circular piece of cardboard having a radius of 17·5 inches, and made an angle of 144° at the centre. He then cut out and then removed from it the sector piece containing the angle 144° and made the bounding radii of the remaining piece coincide, What shape did he get? Calculate its height. S.S. L.C. 1919.

Solution. The shape is that of a cone.

The angle at the centre of the piece cut out $=144°$

$\therefore$ The angle at the centre of the remaining piece $=(360-144)°=216°$

$\therefore$ the arc of this sector $=\frac{216}{360}\times 2\times\frac{22}{7}\times 17{\cdot}5$ in.

$=\frac{3}{5}\times 2\times 22\times 2{\cdot}5$ in.

$=66$ inches.

This 66 inches = the O^{ce} of the base of the cone.

$\therefore$ radius of base of cone $=\frac{66\times 7}{22\times 2}$ in. $=10\frac{1}{2}$ in.

We have $r=10\frac{1}{2}''$ and l *i.e.*, slant height $=17\frac{1}{2}''$

$\therefore h$ or height $=\sqrt{17\frac{1}{2}^2-10\frac{1}{2}^2}$ in.

$=\sqrt{28\times 7}$ in.

$=7\times 2$

$=14$ in. Ans.

Example 2: When a certain weight was cast, it was found to weigh 1·85 lbs. more than was intended. Thereupon a cube, with an edge of 1·5 in. was scooped out from the bottom of it. But thereby the weight was diminished only by 1.08 lb. It is proposed to diminish the rest by scooping out a cone with a bottom circumference of $5\frac{1}{2}$ in. What should be the depth of the cone? [$\pi=3\frac{1}{7}$.] S.S.L.C. 1920.

A cube of 1·5 in. side weighs 1·08 lb.

$\therefore\frac{27}{8}$ c. in. weighs 1·08 lb.

$\therefore$ 1 c. in. weighs $\frac{1{\cdot}08\times 8}{27}$ lb.

$=·32$ lb.

The wt. yet to be removed is (1·85 − 1·08)lb.
= ·77lb.

$\therefore$ vol. to be removed = $\frac{\cdot 77}{32}$ *ie* $\frac{77}{32}$ c. in.

The vol. of the cone must be = $\frac{77}{32}$ c. in.

If h is the height of the cone, its volume = $\frac{1}{3}\pi r^2 h$.

$\therefore 5\frac{1}{2}$ in = O^{ce} of base of cone, its radius = $\frac{11}{2} \times \frac{7}{22} \times \frac{1}{2}''$
= $\frac{7}{8}''$

$\therefore \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \frac{22}{7} \times \frac{7}{8} \times \frac{7}{8} \times h$.
= $\frac{77}{96} h$.

$\therefore \frac{77}{96} h = \frac{77}{32}$

$\therefore h = 3$.

The height of the cone to be scooped = 3″ Ans.

Example: 3. A cylindrical granary with a conical top is 14 ft. in diameter on the inside. The wall is 11 ft. high, and the total height to the top is 14 ft. It was full of grain. Half of it was sold at Rs. 5-12-0 a bag, and the other half at Rs. 5-4-0 a bag. Find the amount realized, given that a bag of grain measures 8·25 c. ft. S.S.L.C. 1920.

The ht. of the cylinder = 11 ft.
The ht. of the conical top = 3 ft.
radius of base of both = 7 ft.

Vol. of Cyl. = $\frac{22}{7} \times 49 \times 11$ c. ft. = 1694 c. ft.

Vol. of Cone. = $\frac{1}{3} \times \frac{22}{7} \times 49 \times 3$ = 154 c. ft.

Total volume = 1848 c. ft.

No. of bags = $\frac{1848}{8\cdot 25}$ *i.e.*, $\frac{1848 \times 4}{33}$ *i.e.*, 224.

Amount realised @ Rs. 5-4-0 each bag is Rs. 1,120 +
Rs. 56 = Rs. 1,176.

@ extra 8 as for 112 bags. 56
Total amount realised Rs. 1,232 Ans.

Example: 4. A circus tent is in the form of a cylinder surmounted by a cone. The cylindrical portion of the tent is of diameter 96 feet, the height of the top of the tent is 36 ft. from the ground, and the height of the cylindrical part 16 feet. Find the total area of the canvas required for the tent. Answer to the nearest square foot ($\pi = 3{\cdot}1416$.)

$$\text{O}^{\text{ce}} \text{ of cylinder} = \frac{22}{7} \times 96 \text{ ft.}$$

$$\text{area of curved surface} = \frac{22}{7} \times 96 \times 16 \text{ Sq. ft.}$$

$$\text{The slant ht. of conical top} = \sqrt{20^2 + 48^2}$$

$$= 52 \text{ ft.} \quad \begin{pmatrix} \text{how ? 5, 12, 13 sides} \\ \text{hence 20, 48, 52} \end{pmatrix}$$

$$\text{area of curved surface of cone} = \tfrac{1}{2} \times 52 \times \frac{22}{7} \times 96 \text{ sq. ft.}$$

$$\text{Hence total curved surface} = \frac{22}{7} \times 96 \left(16 + 26 \right)$$

$$= \frac{22}{7} \times 96 \times 42$$

$$= 22 \times 96 \times 6$$

$$= 11 \times 1152$$

$$= 12672 \text{ sq. ft. Ans.}$$

EXERCISE XIII-A.

Volumes—Cones, etc.

1. Fill in the blanks in the subjoined table.

Cones

	Slant height	Radius of base	Vertical height
i	17	15	—
ii	37	...	12
iii	50	48	—
iv	...	63	16
v	...	120	22
vi	61	—	11

2. The arc of a sector 4·4 inches long and the radius of the sector is 2·5 inches long; if the sector be folded into a cone find the radius of the base: Find the height and also the volume of the cone.

3. Six conical vessels, radius of base 7 cms. and height 24 cms. are to be made of tin-sheeting. Find the area of sheeting required.

4. From a rectangular block of wood 8″ by 6″ by 4″, a conical cavity of depth 3·5″ and radius of base 3″ is scooped out. What fraction of the weight will remain?

5. The arc of a sector is 66 in. long. If the sector be folded into a cone what will be the radius of its base? If the radius of the sector be $17\frac{1}{2}$″, what will be the height of the cone?

6. The contents of a rectangular vessel $6''$ by $6''$ by $3\frac{1}{2}''$, just fill a cone of height 22 inches. Find the radius of its base correct to the tenth of an inch.

7. A conical covering is to be made of canvas to protect the top of a festival car. The base is 21 ft. across and the vertical height is $4\frac{3}{8}$ ft. Find the area of canvas required.

8. A solid cylinder of wood is 18 inches across and 14 inches high. If a cone $11\frac{2}{3}''$ high be scooped out of it leaving $\frac{3}{4}$ of the weight, find the radius of its base.

9. A tower consists of a cylinder surmounted by a cone. Their bases are equal. The cylindrical portion is 28 ft. high and 42 ft. across. The conical top is $15\frac{3}{4}$ ft. high. If the exterior is to be painted at Rs. 4 per 100 sq. ft. find its cost.

EXERCISE XIII-B

Cones—(*Contd.*)

1. A piece of paper in the form of a circular sector of which the radius is 7 in. and the bounding arc 11 inches, is formed into a conical cup. Find the area of the conical surface and also of the base of the cone.

2. A tin-covering is to be made for a cone whose height is 11·2 inches and the radius of whose base 8·4 in. If a single sheet is to be folded for the cover, what must be its shape and dimensions ?

3. A sector of a circle of radius 8 cm. and angle 120° is bent to form the surface of a cone. Find the radius of its base.

4. A conical mound of sand is 35 ft. along the slope and 176 ft. around at its base. Find the volume of sand in the mound.

5. A cone whose height is a'' and the radius of whose base is b'' is immersed in a cylinder whose height is a'' and the radius of whose base is also b''. How much water will overflow ? If again the cone be taken out, what will be the height of water in the cylinder ?

6. A company was manufacturing ounce glasses cylindrical in shape $1\frac{3}{4}$ in. across and 6 in. high. They now propose to make ounce glasses to hold the same quantity, but conical in shape, the top being a circle $2\frac{1}{3}$ in. across. How high must it be?

7. If a conical hole $1\frac{3}{4}$ ft. across and 4 ft. high be scooped out of the base of a cylindrical log of wood 12 ft. long and 2·1 ft. across, what fraction of the original weight will remain?

8. A cone has at its base a circumference of 22 inches. The height is 8·4 inches. If this be cut into equal halves by a plane passing through the vertex vertically down through a diameter of the base, what will be the shape of the section? Find its perimeter and area.

9. German crackers called 'Flower Pots' are conical and are made of very fine tin sheeting. The bigger variety is $5\frac{1}{2}$ inches in circumference at the base and 4 inches along the slope. Find the tin sheeting required for a gross of such pots, whose bottoms are also closed.

10. If a conical heap of pulses $2\frac{1}{2}$ ft .along the slope and $1\frac{1}{2}$ ft. high contains 40 measures, how many measures will there be in a cylindrical basket $1\frac{3}{4}$ ft. across and 4 ft. high?

11. A cylindrical jar internal diameter 8 inches, stands on a horizontal table and contains water to a depth of 10 in.; a lead cone, diameter of base 6 in. height 9 in. is placed in it, with its base on the bottom of the jar. Calculate the height the water level rises, correct to the nearest hundredth of an inch.

12. A tent is in the shape of a cylinder surmounted by a cone. It is to hold 10 men. Each one must have at least 60 c. ft. of air space. If the total height is 12 ft. 6 in. and the cylindrical lower part is 1 foot high, what will be the least diameter of the base?

N. B.—For more difficult types. See Revision Papers.

ON GRAPHS

Constants and Variables

1. (1) The price per viss of sugar is 8 annas. The amount which you will have to pay depends only on the number of viss you buy.

(2) (*a*) You buy a gramophone and some records. The amount which you will have to pay is partly constant and partly variable. If the price of the gramophone is Rs. 120 and the price of each record Rs. 4, the total amount to be paid is $120+4m$. *i.e.*, in equational form $t=120+4m$. (m. denoting number of records and t. total amount to be paid).

(*b*) If you enter the Park Fair grounds, the amount you spend is amount spent in booths + 4 as. which must be paid by all to get into the compound.

(*c*) In a hostel the establisment charges are fairly constant while the monthly expenditure on meals and tiffin varies with number of guests, quality of tiffin, number of feasts or parties specially arranged for.

Boys must have seen why the rates are cheaper with a greater number of guests than with a comparative fewer number; the establishment charges are divided among a greater number of boys.

(*d*) If you print a book, the cost of composing or setting up of types is constant and the other costs vary with number of copies printed.

These examples will make clear that the total (i) does entirely depend on the variable, or (ii) is partly constant or fixed and partly depends on a variable. Anyhow the total is a variable depending entirely or partly on another variable.

2. We have detailed in Books I and II the various types of entirely dependent variables.

The general form of such equations is $y=mx$.

If the total is partly constant and partly variable, the equation is of the form $y=mx+c$.

We derive this form of an equation by taking a concrete example.

A touring and canvassing agent to a merchant is generally paid a fixed salary per month (f), plus a fraction of profits earned, say, one anna per rupee.

Here the income is partly constant (f) and partly depends on the profits earned.

$I = f + \frac{P}{16}$ *i.e.*, income = salary + $\frac{1}{16}$ of profits.

Example: 1. If an officer is paid Rs. 110 in a month when he gets a profit of Rs. 1120, and Rs. 160 in another when he gets a profit of Rs. 1920, find (*i*) his fixed salary (*ii*) his bonus rate.

Theoretical Solution

Suppose his fixed salary is Rs. x

and bonus Re. y for every rupee of profit.

Then $110 = x + 1120y$
$160 = x + 1920y$

Hence $800y = 50$
$y = \frac{1}{16}$.

∴ rate is one anna per rupee.

also $x = 40$ fixed salary.

Graphical Solution

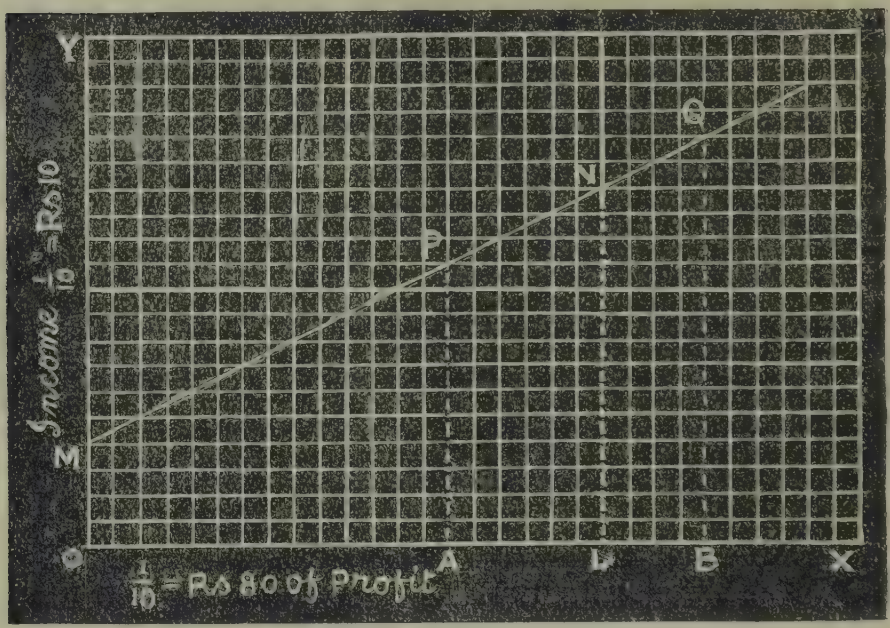
OA represents 14×80 *i.e.*, Rs. 1,120 of profit
and AP ,, 11×10 *i.e.*, Rs. 110 of income
Also OB ,, 24×80 *i.e.*, Rs. 1,920 of profit
and BQ ,, 16×10 *i.e.*, Rs. 160 of income

Points P and Q are plotted. Income and profit relation is the graph MPQ.

From this we can read off corresponding income for given profit or profit for a given income.

Take OL along $x-$axis.

OL = 20 units and represents Rs. 1,600 of profit.



Through L draw ordinate LN to meet graph in N.

LN = 14 units gives Rs. 140 income for a profit of Rs. 1,600.

It is interesting to note that OM gives income for no profit *i.e.*, OM denotes the fixed salary = Rs. 40.

Example : 2. A man carrying 78 lbs. of luggage is charged by a motor Bus office Rs. 1—15 as. whereas another carrying 60 lbs. is charged Re. 1—6 as. Find the weight allowed free and the rate charged per lb. of excess carried.

Theoretical Solution

Suppose x lbs are allowed free and y as. rate per lb. of excess.

Then. $31 = (78 - x)y$

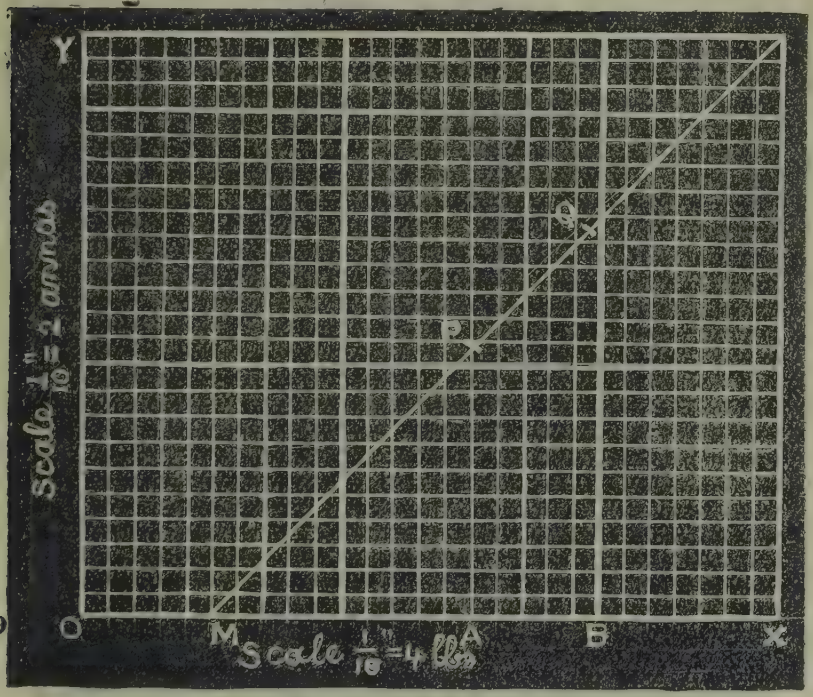
also $22 = (60 - x\ y$

$\therefore\ 18\ y = 9$ and $y = \frac{1}{2}$

and $x = 16$

Graphical

Points P and Q are plotted corresponding to (78 lbs., 31 as.) and (60 lbs., 22 as.)



i.e., P, $(19\frac{1}{2}, 15\frac{1}{2})$ and Q, (15, 11) are plotted

MPQ is the graph.

OM represents weight for no charges *i,e.*, shows weight allowed free = 16 lbs.

Example : **3.** The highest mark secured in an examination is 84 and the lowest is 28. These have to be revised such that the highest is 100 and the lowest is 30. Find a linear formula to effect such a change.

Let the new mark be y and the old be x.

Then $y = mx + c$ is a linear relation.

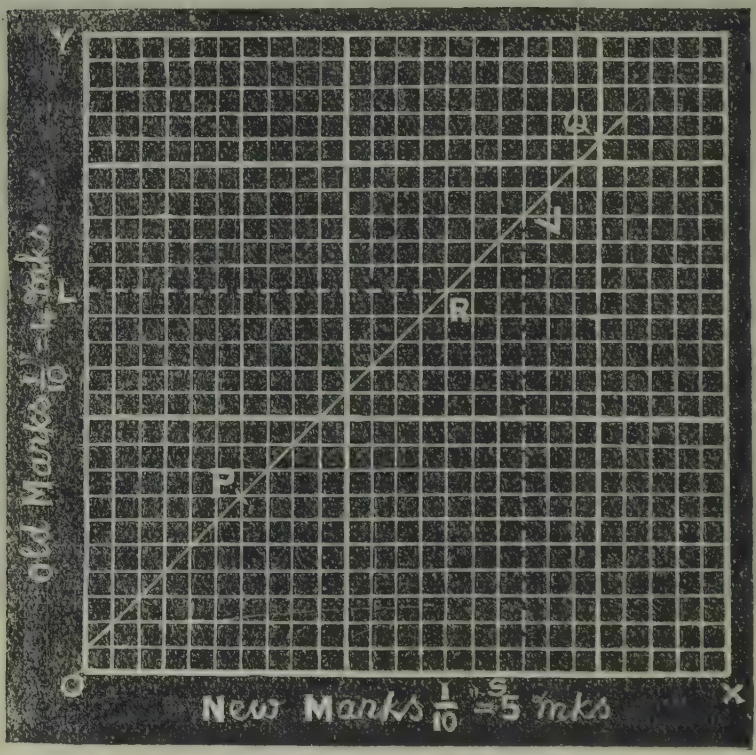
$$100 = 84m + c$$
$$30 = 28m + c$$
$$\therefore\ 70 = 56m$$
$$\therefore\ m = \tfrac{5}{4}$$
and $c = -5$

∴ the old mark in each case must be multiplied by $\frac{5}{4}$ and 5 marks deducted from this to get the new marks.

Graphical Solution

P and Q are plotted to scale noted.

MPQ is the graph.



It is interesting to note that a boy who gets 4 marks orginally gets 0 in the new list.

(*i*) How much will a boy's revised marks be if his original be 60?

OL represents 60.

Through L draw LR to meet graph in R.

Then LR represents 70.

(*ii*) A boy's revised mark is 85. What was it originally?

OS represents 85.

and SV corresponding ordinate represents 72.

Note.—Many types of this kind are given in the exercises that follow. These will be solved both theoretically and

graphically. Many concrete examples may be chosen from everyday life in illustration of the depending variable being partly constant and partly variable.

The gramophone problem, the luggage problem, the hire system, etc. afford familiar types.

To put up a pandal in front I have to pay Rs. 2 to the municipality and 8 as. for every month kept. The total $T = 2 + \frac{1}{2}x$. Such formulae will please be elicited to clinch in this principle.

EXERCISE XIV—A.

Graphs.

1. Plot the following points

(i)	$(3, -5)$	(vi)	$(-\frac{1}{12}, \frac{1}{2})$
(ii)	$(-7, 8)$	(vii)	$(-\frac{1}{3}, 2)$
(iii)	$(-2, -3)$	(viii)	$(-1\frac{1}{3}, -1\frac{1}{4})$
(iv)	$(-7\frac{1}{2}, 3)$	(ix)	$(-\frac{1}{2}, 1)$
(v)	$(-2\frac{1}{4}, 1\frac{1}{3})$		

State clearly the scale chosen in each case.

2. Cocoanuts are sold at Rs. 6-4-0 a hundred. Draw a graph from which you can read off prices up to 2,000 cocoanuts.

3. (i) A cyclist rides uniformly at $7\frac{1}{2}$ miles an hour. Draw a graph of the journey.

(ii) Find from the graph when he would have reached his destination $67\frac{1}{2}$ miles off.

(iii) Also read from the graph where he will be at the end of $1\frac{1}{4}$ hrs. from the time of starting.

4. If a motorist starts from a station at 8 a.m. and drives at 28 miles an hour find graphically when he will reach his destination 35 miles away, if after driving for $\frac{1}{4}$ hr. he had to halt for 10 minutes to effect some repairs in the engine.

5. Riding at $7\frac{1}{2}$ miles an hour a man reaches his destination 18 miles off at 8-10 a.m. Find when he should have left his house. Draw a neat graph to scale.

6. A cyclist rides for a time at 10 miles per hour and then reduces his speed to 8 miles an hour and does a journey of 34 miles in 3 hrs. 39 min. Find when and where he changed his speed.

7. A sum of Rs. 1,400 is lent partly at 8% and the rest at 7% and the total annual interest is Rs. 99. Find the sum lent at each rate.

8. Twenty yards of silk are purchased partly at Rs. 5 a yard and the rest at Rs. $2\frac{1}{2}$ a yard and the total amount paid is Rs. 90. Find the quantity bought at each rate.

9. A man cycled a certain distance at 9 miles an hour and walked back at 10 miles an hour and the total time taken was 3 hrs. 10 min. Find the distance.

10. At billiards A can give 15 points to B and 20 to C in a game of 50. How many can B give C in 70 in order to make an even match?

11. Two trains start at the same time and move towards each other at the rate of 60 and 45 miles per hour respectively. If they meet in 12 min., how far apart were they when they started?

12. A boy is due at a certain place at a certain time. One day he starts at 8-30 a.m. and walking at 4 miles an hr. is 5 min. late. Next day cycling at 10 miles an hr. he is 10 min. early. Find the distance.

8. Solve the equations both theoretically and graphically.—

$$(i)\quad \begin{aligned} 3x+y&=7\\ x+1\tfrac{1}{2}\,y&=0 \end{aligned}$$

$$(ii)\quad \begin{aligned} 2x+5y&=0\\ 3y+x&=1 \end{aligned}$$

$$(iii)\quad \begin{aligned} 2x+4y+1&=0\\ 3y+x+3&=0 \end{aligned}$$

(*iv*) $3x+5y=0{\cdot}9$
$0{\cdot}5y+x=1{\cdot}7$

(*v*) $2x+y+1\frac{1}{2}=3x-y-\frac{1}{2}=18.$

(*vi*) $\frac{3}{x}-\frac{2}{y}=0$
$4x+9y=5$

(*vii*) $7x-16y=1{\cdot}5$
$4x-2y+4\frac{1}{2}=0$

(*viii*) $3x+2y=18$
$5x+4y=32$

(*ix*) $4\frac{1}{6}x+10y=100$
$6x+20y=172$

(*x*) $\frac{x}{3}-\frac{y}{4}=0$

$3x+\frac{y}{2}=11$

14. A cyclist goes to a station 14 miles off, in 1 hr. 10 min., and returns without delay at 20 miles an hour. Find from a graph.

i. when he reaches home again;

ii. the times when he was 5 miles from home.

15. A cyclist rides at 12 miles an hour from a station A. He has to reduce his rate by 2 miles an hour after every $\frac{3}{4}$ hour of cycling. A motorist leaves the same station $1\frac{1}{4}$ hrs. later and travelling uniformly overtakes the cyclist at the 30th mile. Find the speed of the motorist. Illustrate graphically.

16. A man walking from A to B, at the rate of 4 miles an hour, starts one hour before a coach travelling 12 miles an hour and is picked up by the coach. On reaching B, he finds that his coach journey had lasted two hours. Find from purely graphical considerations (i) at what distance from A he was picked up, and (ii) the distance from A to B.

17. A man sets off to a village 18 miles distant walking at 4 miles an hour. At the end of an hour and a half, he

gets a lift and reaches the village in another $1\frac{1}{2}$ hrs. He remains in the town 1 hour and returns on his bicycle at 10 miles an hour. Find from a graph the total time he took to return home and also the rate per hour during the second part of the journey to the village.

18. Two places P and Q are 48 miles apart. A person leaves P at 7 A.M. and motors at 20 miles an hour to R, 18 miles from P. He then returns at double the rate to P, where business detains him for 9 min. He then motors to Q. Another who leaves Q at 9 A.M. walks to P at 3 miles an hour. If both meet at 10 A.M. find the speed of the motorist graphically. Also find when the motorist will reach Q.

19. (i) The cost of printing a forme of 8 pages is (i) a sum of money to set up the type, to impose the forme, etc., before printing is begun, and (ii) a certain rate, fer every thousand copies to be printed. If a denote cost (i) and b, rate (ii) and if x thousands are to be printed, find y the total cost in terms of a, b and x.

(ii) If it costs Rs. 45 to print five thousand copies and Rs. 94 to print twelve thousand copies find a and b.

(iii) Draw the graph of the relation and find from it the cost for printing nine thousand copies.

20. Solving graphically a simultaneous system, the roots were 2,—3. The coefficient of x in the first equation and the coefficient of y in the second were afterwards rubbed out. The equations being $^*x+2y=8$; $3x-^*y=9$ Without finding the coefficients, draw the graphs of the the two equations, using your knowledge of the answer.

EXERCISE XIV—B

1. (a) For late attendance beyond 3 days a student has to pay a fine of 6 ps. for each late attendance. He has also to pay the monthly school-fees of Rs. 1-12-0. If he paid Re. 1-15-0 for a certain month, for how many days was he late ?

(*b*) In another school a boy who absented himself for 8 days paid Rs. 7-8-0 for fees and fine while another who was absent for four more days paid Rs. 9. Find the rate of fine and school-fees.

2. One boy paid Rs. 2-0-0 for school-fees and fine for five days' late attendance, and another pupil in the same class paid Rs. 2-3-0 for the fees and fine for late attendance on eight days. Find the amount of school-fees and the rate of fine for each late attendance.

3. An army of 5000 men costs a country £800,000 per annum to maintain it; an army of 10,000 men costs £1,300,000 per annum to maintain it; what is the annual cost of an army of 8000 men? Take the simplest law which is consistent with the figures given. Find the cost both theoretically and graphically.

4. (*a*) A boy walked to his school at the rate of 55 yds. per minute and was 9 min. late. Next day he walked at the rate of 66 yds. per min. and was 5 min. late; find (i) the distance of the school from his house, (ii) what his rate must be to reach the school in time.

(*b*) I had to go to a place. I found that if I were to travel by a bus just then starting and running at an average speed of 15 miles per hour, I would be late by 12 min., and if I were to engage a taxi which could be driven at 20 miles an hour, I would be 21 min. too early. Find the distance of my destination from where I started.

5. A gramophone with 20 records is sold for Rs. 250, while the same gramophone with 28 such records is offered for Rs. 276.

i. Find the price of the gramophone alone from arithmetical considerations.

ii. If x denote the price of the machine in rupees and y the price of each record, frame two equations in x and y and draw their graphs. What do the coordinates of the intersection point give?

iii. Can you draw a single straight line graph to read off the price of the gramophone with a given number of records? Find from the graph the price of a gramophone with 24 records.

6. A permanent officer draws a starting salary of Rs. 120. He is given an increment of Rs. 5 per annum. When will he draw a salary of Rs. 150 ? In how many years from the date of his entering service will he draw Rs. 250 ?

7. A teacher is appointed on a salary of Rs. 90 per month and he is given an annual increment of a few rupees. If at the beginning of a year his salary is Rs.115 and he has worked for 5 years, find the annual increment.

8. A teacher who gets an annual increment on his pay draws Rs. 104 at the beginning of the 7th year of his service and he drew Rs. 96 at the beginning of the 5th year of his service. Find his initial salary and annual increment.

9. The marks obtained by students in a certain examination had to be raised. In so doing the marks of boys who secured originally 21 marks and 42 marks were raised to 33 and 61 respectively. Find the revised marks of boys who secured 33 and 62 in the original list and the original marks of boys whose revised marks were 53 and 69.

10. In a furlong race A beats B by 40 yards, and C by 60 yards. By how many yds. can B beat C in the same race ?

11. In a half-mile race A gives B a start of 180 yds and both run a dead heat. If they both run from scratch and run a quarter-mile race, by how many yds. can A beat B, supposing their rates of running to be the same and uniform throughout ?

12. When will the hands of a clock be together, at rt. angles, and in a st. line, between 4 and 5 o'clock ?

13. Passengers by a motor-bus service are allowed a certain weight of luggage free and the rest is charged. If a passenger carrying 28 lbs. is charged 8 as, and another carrying 32 lbs. is charged 10 as., find the weight of luggage allowed free and the rate of charge per lb.

14. When there were 18 students in a hostel the total expenses of the hostel in a month came to Rs. 243, and when there were 30 students, the expenses came up to Rs. 375. If x denote the constant expenditure that should be incurred whatever the strength of the hostel be, find that

constant expenditure and the total cost if there were 45 students in the hostel.

15. (*a*) A certain printer charges Rs. 2 for the first thousand copies of a notice and Re. 1-4 as. for every additional thousand; while another charges Re. 1-8 as. for every thousand, no matter how many copies are printed. I found that for the copies I had to print, it cost me the same if I gave the work to the one or the other. How many thousands had I to print ?

(*b*) Draw two graphs with the same axes and scale, to read off the costs. Find from the graph when the costs will be the same.

16. A village schoolmaster's income is derived from a fixed monthly allowance of Rs. 15 subscribed by the village community and school-fees at 12 as. per pupil. Frame an equation connecting the total income and the number of pupils and draw its graph.

A schoolmaster in an adjoining village gets his income only from school-fees and charges each student Re. 1-4 as. The strength of each school is the same and emoluments are also the same, Find graphically the number of students in each school.

17. Passengers by a bus are allowed 10 lbs. of luggage free and the excess is charged at 8 ps. per lb. Another allows no luggage free and charges 6 ps. per lb. Draw two graphs with one and the same axis and find from the graph :

1. when the two charges come to the same amount;
2. when the charges differ by an anna.

Motion and Velocity

1. The following points already discussed in Book I should be impressed in the minds of the pupils.

(1) If two persons walk in opposite directions towards each other ; distance between at a particular moment ÷ sum of their rates, gives the time of meeting after that particular moment.

(2) If they walk in the same direction ; distance between at a particular moment ÷ the difference of the rates, gives the time of overtaking or of being together after that particular moment.

(3) Symbolically $\frac{D}{E}$ *i.e.*, Distance between ÷ Effective rate, gives time of being together. The effective rate is the sum of the rates, if they walk towards each other and the difference if they walk in the some direction.

The idea of 'Effective rate' should be thoroughly drilled in by examples. Effective rate simply means the rate that counts or is effective.

2. A road runs from P to S passing through Q and R. PQ is $10\frac{1}{2}$ miles and QR. 7 miles. A starts from P at 6 A.M. and walks to S at a uniform rate, halting at Q for half an hour and at R for one hour. B starts from P at 7 A.M. on his cycle, his rate, of cycling being 7 miles an hour. He passes A at 7-45 A.M., and goes to R where he stops one hour. He returns to Q, where business detains him for an hour and a half. He then goes straight to S, which he reaches at 4 P.M. Find the distance from P to S, A's rate of walking, and the time when he reaches S.

Represent the above graphically and find from the graph when and where A and B will be together.

i. Mark Q and R to scale along Y-axis. (We cannot draw the graph of A's journey to begin with, as data are wanting.)

ii. The graph of B's journey can be drawn. B*ap* in the figure.

iii. At 7-45 A.M. A and B are together. Therefore draw a vertical at a distance of 3 divisions from B. This ordinate meets B's graph at *a*. Therefore P*a* must be the graph of A's journey in as much as A had started at 6 A.M. and was with B at 7-45 A.M.

iv. Continuing A's graph, *et* shows halt at Q (time advances, no progress in distance) *tq* is parallel to P*e*, for A continues at the same rate. *gh* again shows halt at R and *hcd* is continuation of A's journey.

v. Taking B's graph, B*p* is the graph till he reaches R, *pq* rest at R. *qr* returning at the same rate to Q, so that the co-ordinates of *r* show that he has returned to Q and that while distance has become less, time has advanced. *rs* his rest at Q, *st* shows his graph. It is parallel to B*p* for he is at the destination at 4 P.M. travelling at his own rate. Therefore draw a parallel to X-axis through *t* to meet Y-axis at S.

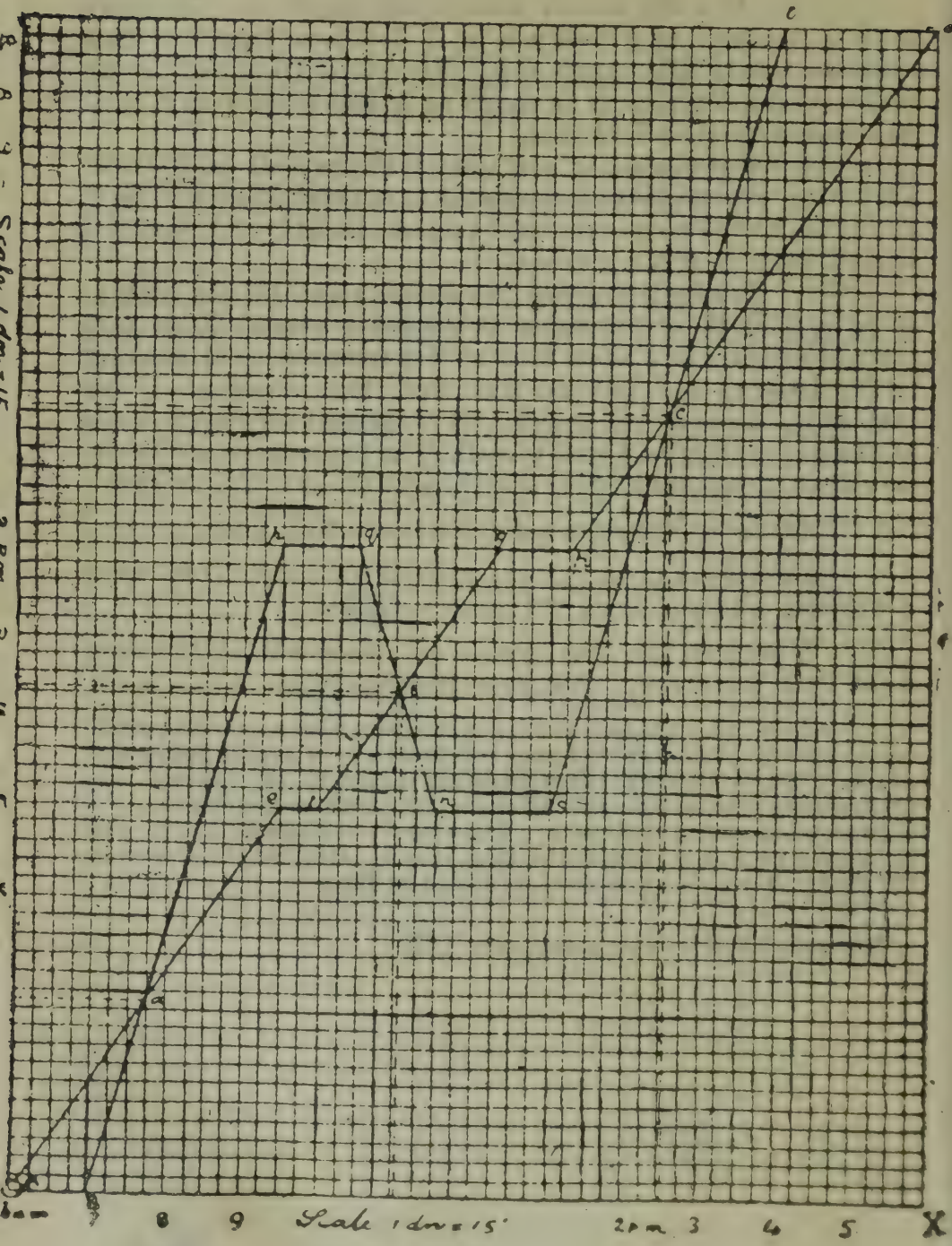
Answer.—PS is the total distance $= 31\frac{1}{2}$ miles.

A's rate is given by the ordinate through B to meet A's graph, which is 6 ds. = 3 miles an hour.

Wherever the two graphs cut they will be together. Read from the graph. OX gives the time when A reaches S.

N.B.—This problem embodies a number of Principles of graphical solution of questions on Time and Distance—viz. (i) Finding rate graphically, (ii) Finding times of being together, (iii) Finding time of reaching destination, (iv) Drawing graph of return journey, (v) Representing rest graphically. Therefore the teacher will do well to explain each step clearly, eliciting step by step the answers from the boys. A big diagram must be drawn by them.

For graphical solution see page 122.


c
d
C
A
Q
P
B
R
S
e
a
8
9
Scale 1 dm = 1
2 m
3
4
5
X

Motion in a Circle

3. Consider the following problem :—A motors at 60 m. p. h. and B goes by a jutka at 5 m. p. h. Both travel in the same direction.

(*a*) If they start from the same place when will they be 15 miles apart, 30 miles apart and 45 miles apart ?

(*b*) If B is 10 miles ahead of A, when will they be (i) together, (ii) 15 miles apart, (iii) 45 miles apart. (iv) 30 miles apart supposing both of them started at 2 P.M. ?

Example 2.—When will the hands of a clock be

(*a*) together, at rt. angles and in a st. line between 12 and 1 o'clock ?

(*b*) together, at rt. angles and in a st. line between 2 and 3 P.M. ?

N. B.—Note the relation between this question and the previous one.

Example 3.—When will the hands of clock be (i) together, (ii) 10 min. apart, (iii) at rt. angles, (iv) in a st. line between,

(*a*) 5 and 6 o'clock.

(*b*) 11 and 12 o'clock.

In all such problems find the number of minute spaces between the min. hand and the hour hand.

(*i*) This space if overtaken or gained, the hands are together.

(*ii*) If this space+15 min. spaces be gained the hands are at rt. $\angle$s.

(*iii*) If this space+30 min. spaces be gained the hands are in a st. line.

(*iv*) The hands are x min. apart when this space+x min. are gained.

To gain 55 min. the min. hand requires 60' . . . .

To gain 1 min. „ „ $\frac{12}{11}$ min.

∴ Multiply by $\frac{12}{11}$ the number of minute spaces that have to be gained by the min. hand when it strikes the previous of the two given hours. The result is the number of minutes after that particular hour.

i.e., $\frac{12}{11}\times$ number of minute spaces to be gained gives the time required.

Example 4.—(A) *N.B.*—When the min. hand makes 12 rounds the hour hand makes 1.

i.e., the min. hand gains 11 rounds in 12 rounds.

1 round in $\frac{12}{11}$ rounds.
2 rounds in $\frac{12}{11}\times 2$ rounds.
x rounds in $\frac{12}{11}\times x$ rounds.

When $x=11$, the min. hand gains 11 rounds in 12 rounds *i.e.*, the hour hand and the min. hand are together after 12 rounds.

(B)—Two persons whose rates of running are as 13 : 10 run round a circular course. At how many points are they together if they start from the same place ?

the faster gains 3 rounds in 13 rounds.

1 round in $\frac{13}{3}$ rounds.
2 rounds in $\frac{13}{3}\times 2$ rounds.
3 rounds in $\frac{13}{3}\times 3$ rounds.
x rounds in $\frac{13}{3}\times x$ rounds.

Hence they will be together when the faster has run $4\frac{1}{3}$ rounds, $8\frac{2}{3}$ rounds and next 13 rounds, when, they both will be together at the starting point.

Hence if rates of two people running in the same direction round circular course be as $a : b$ $(a>b)$ they will be together $(a-b)$ times at the last of which they will be together at the starting point. and if they continue, the same thing will be repeated. It should be noted however that $\frac{a}{b}$ must be in its lowest terms.

(C)—If they walk in opposite direction with rates as 13 : 10. then.

When the faster goes $\frac{13}{23}$ of the round the slower goes $\frac{10}{23}$ of the round—1st time of meeting.

When the fastet goes $\frac{26}{23}$ of the round the slower goes $\frac{20}{23}$ of the round—2nd time of meeting.

When the faster goes $\frac{39}{23}$ of the round ,, ,, $\frac{30}{23}$ x of the round—3rd time of meeting.

When the faster goes $\frac{13}{23}x$ of the round ,, ,, $\frac{10}{23}$ of the round—xth time of meeting.

If $x=23$, they meet again at the starting point.

Hence $a+b$ denotes the number of meetings, the last of which is being together at the starting point.

Trains and their lengths

2. (1) A train is 132 yds. long runs at 15 miles an hour. How long will it take to clear a telegraph post?

Note: Distance run = its own length. ∴ time taken = 18″.

(2) How long will it take to clear a platform 242 ft. long?

Distance run = its own length + length of the platform. *i.e.*, 638 ft; time = 29″.

(3) How long will it take to clear a man walking in the same direction at $3\frac{3}{4}$ miles an hour?

Distance run = its own length and rate being, (its own rate—the man's rate.) *i.e.*, $2\times396/33=24$″.

(4) How long will it take to clear another train running in the same direction at $7\frac{1}{2}$ miles an hour; the length of the latter being 220 yds.

Distance run = its own length + the length of the other and the rate = its own rate − the rate of the other. *i.e.*, $1056/11=96''=1'-36''$.

(5) How long will it take to clear a man walking in the opposite direction at 5 miles an hour?

Distance run = its own length and rate (being its own rate + the man's rate). *i.e.*, $\frac{396\times3''}{88}=13\frac{1}{2}''$.

(6) How long will it take to clear the train running in the opposite direction? vide 4 *supra* for particulars of the other train.

Distance run = its own length + the length of the other. Rate being the sum of their rates.

N.B.—All the six cases might be included in one formula, where T denotes time of crossing,

$$T = \frac{L_1 + L_2}{E}$$

L_1 & L_2 lengths and E the effective rate.

The teacher is requested to apply this formula in the solution of questions of the type. The applicability to all cases must be clearly explained.

EXERCISE XV

1. (i) A column of infantry is marching at $3\frac{3}{4}$ m. p. h. How long will it take to pass a milestone? The length of the column is 55 yds.

(ii) If a train 121 ft. long clears a bridge $\frac{1}{2}$ furlong in 10″, find its speed in m. p. h.

(iii) A train clears a platform $\frac{1}{2}$ furlong in 10″ and a man in $2\frac{1}{2}$″. Find its rate and its length.

(iv) A train clears a bridge $\frac{1}{2}$ mile long in 1 m. 25″ and a man in the train has seen the bridge for 1 m. 20″. Find the length of the train and its rate.

(v) A column of infantry is marching fast at $7\frac{1}{2}$ miles an hour. It is $\frac{1}{2}$ furlong. A cyclist takes a message from the rear to the front, *i. e.* from the last man to the first cycling at 15 m. p. h. How long will it take him to take the reply from the front to the rear?

(vi) A railway train passes a platform 66 yds long in 14″. It halts at a siding. Another train 132 yds. long running on a parallel line at 45 m. p. h. clears this in $6\frac{1}{2}$″. Find the rate and length of the previous train.

2. The Coleroon Railway bridge is nearly 6 furlongs. How long will it take the Boat Mail to clear it, if the speed be 10 miles an hr. and the length of the Boat-Mail be 110 yds.?

3. A tunnel is 3 miles long. In how many minutes will a train 132 yds. long running at 15 miles an hour clear the tunnel?

4. The Cauvery bridge is 2 fur. long. A column of infantry is marching at 3 miles an hour. If the file be 100 ft., when will it clear the bridge?

5. Two trains measuring 330 feet and 264 feet respectively, run on parallel lines of rail. When travelling in opposite directions they are observed to pass each other in 9 seconds but when they are running in the same direction at the same rates as before, the faster train passes the other in $22\frac{1}{2}$ seconds. Find the speeds of the two trains in miles per hour.

6. A train l yards long, running at m miles an hour clears a platform in n seconds. If the length of the platform in yards be x, establish a relation between x, l, m and n.

A person standing on a Railway platform 264 yds. long noticed that a train passed the platform in 20 seconds and himself in 8 sec. Using the above relation find the length of the train and its rate per hour.

7. Two trains running in opposite directions pass each other in $2\frac{1}{4}$ seconds. Their rates are 48 and 42 miles per hour. one of the trains is 155 feet in length; find the length of the other.

8. When will the hands of a clock be in a straight line between 3 and 4?

9. When will the hands be at rt. angles between one and two o'clock. How many positions will there be?

N. B.—Many questions of this type can be orally proposed and answers easily elicited.

Miscellaneous Examples

Many choice types are given in this set. These systematically drilled in will, by themselves, afford a thorough revision in Form VI.

1. The outside dimensions of a cistern are 6 ft. 8 in. long, 4 ft. 4 in. high and 3 ft. 5 in. broad. The lead is 1 in. thick. There is no top to it. Find the weight of the lead.
(1 cub. ft. of lead weighs 2,160 oz.)

2. The gross receipts of a certain co-operative concern in a certain year are apportioned as follows: 40% to pay the working expenses. 54 % to give the share-holders a dividend at the rate of $3\frac{1}{2}$ % and the remainder Rs. 2,835 is reserved. Find the paid-up capital of the company.

3. An arch in the form of an arc of a circle of radius 20 ft. crosses a stream 30 ft. wide. Find by calculation the height of the centre of the arch. Check the result by careful drawing to measurement.

4. A man buys $(4x+5a)$ lb. of tea at 1s. 10d. per lb. and $(x-a)$ lb. at 2s. per lb. and sells the whole at 1s. $9\frac{1}{2}$d. per lb. What is his gain? Show that his gain is the same for all values of a.

5. A man sells an article and gains 20 per cent. Had he sold it for a penny more, he would have gained 25%. What was the actual selling price?

6. A works for 2 days and then being joined by B, the task is finished in 2 days more. Had B first worked for 1 day and then been joined by A, the task would have been finished in 2 days more. How long would A, working alone, take to do it?

7. The interest on a certain sum of money invested at compound interest is £12-8-4 at the end of the first year and £13-8-8 at the end of the second year. Find the rate of interest and the sum of money.

8. If 1 cub. in. of gold weighs 10'2 oz. and 1 c. in. of silver weigh, 5'5 oz., find the quantity of each in a mixture containing 5 cub. in. which weighs 34'55 oz.

9. A reservoir 80 ft. long and 40 ft. wide is to be made in a rectangular piece of ground extending 10 ft. beyond each end and side. If the soil removed be placed uniformly on th surroun-

ding portion of land, to what depth must the ground be excavated so that the resulting depth of the reservoir may be 5 ft.?

10. A man-of-war 814 ft. long travelling at 20 miles per hour is overtaken by a boat 154 ft. long. A passenger looking through a port hole of the bigger notices that it takes 7 seconds for the boat to pass him. How long would the boat take to pass the man-of-war if going in the opposite direction?

11. How many viss of coffee at Rs. 3-8-0 a viss did I buy, if by selling it at a profit of $16\frac{1}{2}\%$, I make Rs. 315 more than if I had sold it at a profit of $15\frac{3}{4}\%$?

12. A and B are running round a circular track. A does every lap in 3 min. 12 secs. and B in $3\frac{1}{2}$ min. How long will it take A to be with B together for the first time. How many laps will each man have then made?

13. If a man goes b miles at x miles an hour and then c miles at y miles per hour, find his average speed z in terms of b, x, c and y. Find z if $b=6$, $c=12$, $x=3$, $y=4$.

14. The dimensions of a swimming bath are length 8 yds., breadth 15 yds. 2 ft., depth (at deep end) 8 ft. decreasing uniformly to 3 ft. 6 in. at shallow end. Of course the sides are vertical, top horizontal, bottom inclined. A cub. ft. of water weighs 62·4 lbs. and a gallon weighs 10 lbs. Find the number of gallons of water required to fill the bath.

15. The Severn tunnel, the longest in the British Isles, is 4 miles 638 yds. If an express train travels at the rate of 60 miles an hour, find, correct to a second, the time taken to clear the tunnel by (i) a passenger seated in the train, (ii) the guard walking at 3 miles an hour along the corridor towards the engine.

16. Show that there are two triangles satisfying the conditions:—

$AB=6$ cm., $BC=4{\cdot}5$ cm., $\angle BAC=30°$.

Find the length of CA in each case by measurement.

Also the magnitudes of BCA in each case.

17. A piece of paper a mile long is rolled round to form a solid cylinder of paper. Find its diameter, given that 300 such sheets make a pile an inch thick.

18. (i) A field containing 2 acres is in the form of a quadrant of a circle. What is the length of the boundary?

(ii) What decimal of a stone is 1 lb. 5 oz.?

Give your answer (i) correct to 2 decimal places.

(ii) correct to 2 significant figures.

19. The income tax is lowered from 1s. to 8d. in the pound and the revenue from this source is thereby increased 12 per cent. Find the increase per cent on the amount of income taxed.

20. A and B start from two towns P and Q and walk towards one another; A at the rate of 3 miles an hour, B at $3\frac{1}{2}$ miles an hour. 20 minutes afterwards C starts from Q and walks towards P at $4\frac{1}{2}$ miles an hour; where will C overtake B? If C meet A, 18 minutes after passing B, determine the distance from P to Q.

(NOTE,—The pupils shall be asked to illustrate the problem graphically.)

21. What would it cost to varnish the outside of a cubical box without lid at 4d. square foot, if it cost 3s. 6d. to varnish one with a lid of the same width and depth, but half as long again at 5d. per square foot?

22. ABCD is an isosceles trapezium, AB parallel to CD; AB=120 yds., CD=80 yds. and $\angle$s A and B each=60°. Draw a plan to scale.

With centre C and radius 40 yds. an arc is drawn inside the figure to cut CD in E and CB in F. Again with centre D and radius DE an arc is drawn to cut AD in G. Also with centres A and B and radii AG and BF arcs are drawn inside the figure to cut AB in K and L respectively. The curved portions show pathways. Find their total length.

23. A sheet of cardboard is formed into a hallow cylinder $10\frac{1}{2}$ in. high and $2\frac{1}{2}$ in. in diameter. Find the area of the sheet.

24. A wall map is 4 ft. long and 2 ft. 2 in. wide. An exact reproduction is made on a different scale the length being 40 cms. Find (i) the width of the new map, (ii) the length of a line on the wall map which is 12·4 cm. long on the reproduction, (iii) the area of a square on the reproduction which has a side of 6 in. on the larger map.

25. In ten gallons of a mixture of milk and water, 5% is water. How much water must be added to make the water form 10 % of the mixture ?

26. (i) In a circle of d in. diameter, what angle will an arc x in. long subtend at the centre and what length of arc will subtend an angle of y° at the centre?

(ii) If an article is sold for £ x at a gain of y %, what did it cost ? Given that x=£ 851-4s. and y=12 find the cost price.

27. A certain length of pathway has to be constructed. It is found that 3 men can construct $\frac{1}{5}$ of it, all but 1 mile, in 2 days, whilst 18 men can construct 1 mile more than $\frac{2}{5}$ of it in 1 day. What is the length of the path ?

28. Three cyclists A, B and C start together and ride the same way round a track 270 yards in circuit, their rates being 18, 14 and 10 yds. per second, respectively. After how many seconds will they again be together and how far from the starting place ?

29. A town is supplied with water from a reservoir which is fed by a stream of uniform volume; when the reservoir is full, if 32,000 gallons are used daily, the supply fails in 50 days: if 37,000 gallons are used daily, it fails in 40 days. How much water can be used daily without the supply ever failing ?

30. A circular arch over a stream rises 3 ft. at its highest point above the level of the tops of the vertical piers. If the distance between the piers is 20 feet, find the radius of the circle of which the arc forms a part and draw a diagram to scale.

31. A cylindrical pipe $2\frac{1}{2}$ ft. in diameter discharges 3300 gallons per minute from a reservoir. Find the speed of water in the pipe in miles per hour. 1 cub. ft. = $6\frac{1}{4}$ gallons.

32. A tree was standing vertically. Blown by the wind, it broke without parting asunder and the top of the broken part 40 feet long touched the ground at a distance of 20 feet from the foot of the stump. Find (i) the length of the path traced by the top of the broken part (ii) the height of the tree to the nearest foot.

33. A pint bottle is emptied in filling six equal conical wine glasses each of which has a depth of 2·1 inches. Given that 1 gallon = 280 cub. in., find the radius of the rims of the glasses. The radius must be calculated to the nearest hundredth of an inch.

34. A column of soldiers $\frac{3}{4}$ of a mile long is marching along a road at the rate of $4\frac{1}{2}$ miles an hour. How long will it take a cyclist. riding at the rate of 12 miles an hour, to carry a message from the rear of the column to the head and return to the rear again ?

35. An ornamental flower-bed is made thus :—A square plot of 12 feet side is chosen. With each corner as centre and radius = 3 ft. circles are described to fall outside the square. Again semi-circles are described on the remaining portions of straight sides, to fall inside the square. In the centre there is a hexagonal fountain of 2 ft. side. The area bounded by the curved lines with the exception of the fountain, is turfed. Find the area of the turfed portion.

36. A cube weighs 56 lbs. and the area of one of the faces is 40 sq. in. What is the area of one of the faces of a cube of the same material weighing 875 lbs ?

37. A plan of an oblong field of 4 acres is drawn to a scale of half an inch to one chain and one side of the plan is 4 inches in length. If fencing costs 3 as. a yard, find the least cost at which the field can be divided into two equal fields.

38. If Alexander had lived 9 years less he would have reigned $\frac{1}{8}$ of his life, but if he had lived 9 years more he would have reigned $\frac{1}{2}$ of his life. How long did he live and at what age did he come to the throne ?

39. A motor car started for a station 12 miles off at 11-15 A.M. and 5 minutes later, it overtook a cart going in the same direction at the rate of six miles an hour. The car reached

the station at 11-55, waited there for 10 minutes and then returned at the same rate as before. When and where would it meet the cart? (Both for graphical solution and a theoretical solution.)

40. The parallel sides of a trapezium are 7 and 12 inches and the other two sides are 5″ and 6″. Draw a figure to scale and calculate the area.

41. There were in a certain year thrice as many boys as girls in a school. Next year the strength of the boys fell down by 12 per cent and that of the girls rose by 40 per cent. Find the ratio of the boys to the girls and also the increase per cent in the total strength of the school.

42. An observer from an aeroplane noticed the angle of depression of an enemy's gun to be 45°. He flew 1000 ft. vertically below and then the angle of depression of the gun was 30°. How high was he flying? Calculate the height from a neat figure drawn to scale.

43. Two motor cyclists A and B rode a distance 50 miles. They started together and A's time was 4 hrs. 10 minutes. B rode 3 miles an hour faster than A but took rest for 10 minutes at the end of every hour. Who reached the destination earlier and by how many minutes? Determine graphically.

44. The length, breadth and height of a room are all equal and the length of a string connecting one bottom corner to the opposite top corner is 60 ft. Find the cost of whitewashing (to the nearest anna) of the four walls and the ceiling at Rs. 3-8 as. per 100 sq. ft.

45. An express train must leave a station at 8 p. m. A goods train has to be started earlier. The latter must reach a station 63 miles off running at 18 miles an hour without being overtaken on the way by the express which runs at 24 miles an hour. Find graphically the latest time when the goods train must be started from the station.

46. A merchant marked his goods at an advance of 25% on cost. After selling $\frac{1}{3}$ of the goods, he finds that some of the goods on hand are damaged so as to be worthless. He marks the salable goods at an advance of 10% on the marked

price and finds in the end that he has made 20% on cost. What part of the goods was damaged?

47. A and B are two towns 26 miles apart: C is a town due East of A and due North of B. A man starts from A and drives at 5 miles an hour to C; at the same time another man starts from B and cycles to C at 12 miles an hour and they reach C at the same time. Find the distance of C (i) from A (ii) from B.

48. A rectangular silver sheeting $12'' \times 11'' \times \frac{1}{2}''$ is beaten into a circular sheeting 0·05 of an inch thick. Find the diameter of the circle correct to the nearest hundredth of an inch.

49. The ends of a workshop are 80 feet apart, the height at the ridge of the roof 14·5 feet and at the eaves 9 feet. The workshop is 120 feet long. What is the floor area in square feet and the air space in cub. feet?

50. If 19 pounds of gold and 10 pounds of silver each loose 1 pound when weighed in water, find the amount of each in a mass of gold and silver that weighs 106 pounds in air and 99 pounds in water.

51. A grocer has three different kinds of tea which cost him 1 s.−3 d., 1 s.−6 d. and 1s.−8 d. a pound. With these he makes two mixtures of equal value; each mixture is made of two sorts of tea combined in the same proportion by weight as in other. How is this done?

52. A vessel is formed by cutting a conical hole out of a cylinder, radius 6 in., the vertex of the cone being at the centre of the base of the cylinder. If the height of the vessel be 12 inches and if it will hold 314 cub in. when just full, find the thickness of the top of the vessel.

53. Describe a circle whose radius is r''. Draw a diameter AOB, O being the centre, A and B on the circumference. Draw $OC = a''$ perpendicular to AOB, $a < r$. Join AC and produce it to meet the circumference in D. Find in terms of r and a the area of the triangle ADB.

54. A person A buys an estate and sometime afterwards disposes of it to another B for Rs. 5,400. At this

price it yields B, $2\frac{3}{4}$ per cent. Owing to careless management A was getting Rs. 36 less than B and that income worked up to A, 3 % of his investment. What did A originally pay for it?

55. A cubical box, of external dimensions 17 inches each way would contain crushed ore of the value of £ 421 17s. 6d. If it were made of material 1 inch thick; but by mistake, it has been made of thicker material and the difference in the value of the ore which will hold is consequently £ 78-17s.-6d. What is the real thickness of the material?

56. Each side of a regular hexagon is trisected and a circle is passed through all points of division. If a side of the hexagon is 6 inches, find the area of the circle.

57. The population of a town during a certain period increased from 15,700 to 17,427. The population of another town during the same period increased at twice as great *a rate*. The population of the second town at the end of the period was 13,908. What was it at the beginning of the period?

58. A piece of timber is cut up. Of two pieces, the first is 12 ft. 6 in. long, $10\frac{1}{2}$ in. wide and 10 in. thick and this weighs 320 lbs. The second is 10 ft. long, 9 in. wide and weighs 153·6 lbs. What is its thickness?

59. An assistant examiner is to be given a remuneration of a as. per paper valued by him; but if the submission of the results be delayed, he will have to pay a penalty of Rs. r for every day beyond 30 days allowed. An examiner who had to value c papers took b days to value them and received Rs. M. Establish a relation between, M, a, b c and r. Given that b is greater than 30.

If $M=200$, $b=32$, $a=8$, $c=420$; find r.
and if $M=180$, $b=34$, $r=5$, $c=320$; find a.

60. There were d dozen oranges in a basket. The seller offered them at a annas per dozen on an average. I however selected s dozen oranges. The seller therefore demanded 2 as. more per dozen, which I paid. At what price per dozen must the remainder be sold, that the seller may realise the

amount she could have realised if the whole were sold at the average rate?

61. (*a*) From a point without a circle two tangents are drawn making with each other an angle of 60 degrees. The length of each tangent is 15 inches. Find the diameter of the circle.

(*b*) Find the area of an equilateral triangle circumscribed about a circle whose radius is 8 meters.

62. A square fort 300 yards each way, has a gate in the centre of each side. There is a shrine just in front of the Northern gate. One day I walked 75 yds. directly south from the southern gateway and then walking 2,400 yards directly to the East, observed the shrine just beyond and in a line with the North-East corner of the fort. Draw a neat diagram to scale and find by calculation how far the shrine is (i) from the North gate and (ii) from my point of observation.

63. Two men walk along a railway track, one at 3 miles an hour, and the other at 4 miles an hour, in opposite directions. A train going in the direction of the first man takes six seconds to pass him; the same train takes 5 seconds to pass the second man. What is the length of the train in feet?

64. A cube of edge 1 in., is placed on the table. A right circular cone, having the length of its sloping edge equal to the diameter of the base, just covers the cube and rests on the table. Find the height of the cone.

65. If x metres $= y$ feet and c shillings $= d$ francs, express a price of 7 francs per metre in shillings per yard.

66. How many square yards of canvas are required to make a tent, the top of which is a cone 7 ft. high and the bottom a cylinder 2 ft. high, the diameter of the base being 11 ft.?

67. A square, a regular hexagon and a circle are between the same parallels. If the side of the smallest in area be represented by 1, what numbers, correct to 1 decimal place, will represent the areas of the two other figures?

68. In the fable of the 'Hare and the Tortoise' supposing that the hare did a mile in 6 minutes and the tortoise in 2 hours, if the hare commenced its sleep having run half way, find how long it should have slept if on waking up it ran at its usual rate and was 44 yds. behind the tortoise, the race-course being a quarter of a mile.

69. In a certain year in order to meet the expenses of a public function, a rate of $8\frac{1}{4}$ pies per rupee of pay drawn by officers was fixed. Next year the pay drawn by officers rose by 10 per cent while the estimated expenses also increased by 24 per cent. Find to the nearest tenth of a pie what the new rate must be. (Explain the term 'rateable value.')

70. (i) If the circumference of a circle is divided in the ratio $a : b$, what angles do the two arcs subtend at the centre?

(ii) If an article is sold for Rs. x, at a loss of y per cent, what did it cost?

71. 1 c. ft. $= 6\frac{1}{4}$ gallons and 8 pints $= 1$ gallon. A cylindrical glass holds half a pint. If the internal diameter of the glass is 2·4 in., find the internal depth correct to the hundredth of an inch.

72. A car deteriorates, 40 per cent in value during its first year's use and during each subsequent year by a certain other fixed percentage of its value at the beginning of each year. A car bought 4 years ago for Rs. 4,800 would now fetch Rs. 1,800. What will it be worth in another 3 years?

73. Last year, in England, the cars of a certain tramway company were running on 312 days, and the total receipts from fares amounted to £3,757. Each passenger paid either 1 d. or 2 d. and the number of penny fares was to the number of two-penny fares as 7 : 5. Find the average number of penny and two-penny passengers carried each day.

74. An alloy consists of 250 grammes of bismuth, 400 of tin and 650 of lead. How much tin and how much lead must be added to make a new alloy, of which one-half is tin and one-tenth bismuth.

75. Two trains start from stations A and B at the same time. If the train from A reach B and the train from B

reach A, 18 minutes and 8 minutes respectively after the trains meet, compare their speeds.

76. From the corner A of a square $ABCD$ construct with your instruments a line AP to meet CD in P so that the area of the triangle $APD = \frac{1}{5}$ that of the square.

(Full geometrical construction must be shown.)

77. Two men and a boy can do a piece of work in 5 days while a man and two boys can do it in 6 days. If the man is paid Re. 1-12-0 a day, how much should the boy be paid?

78. MN is a line 20 ft. long. AM, 21 ft. long and BN, 16 ft. long are both drawn perpendicular to MN through M and N. AB produced meets MN produced in P. Calculate the lengths of PN and AB.

79. The sides of a rectangle are as 5 : 12. If the first side be lengthened by 14 ft. and the second shortened by 8 ft., the diagonal of the new rectangle is the same as that of the old. Find the sides of the old rectangle.

Revision Papers

I

1. Two varieties of cocoanut oil are mixed together. The superior costs Rs. 0-12-6 a measure and the inferior Rs. 0-9-9 a measure. If 24 measures of the superior be taken, how many measures of the inferior must be mixed with it, so that by selling each measure of the mixture at Rs. 0-11-3 the seller may gain $12\frac{1}{2}$ per cent on his outlay?

2. A money-lender borrows Rs. 6000-0-0 at 12 per cent per annum compound interest. He lends forthwith Rs. 2,500-0-0 to A at 18 per cent., Rs. 3,000-0-0 to B at 15 per cent., the interest in each case to be added to the capital at the end of each year, and buys a motor-bike with the balance. At the end of two years he collects all the amounts due and pays his creditors; but the motor-bike can fetch only 20 per cent of the amount invested on it. How much to the nearest rupee can he gain in the transaction?

3. A gentleman has to go to a place 33 miles distant. He can bike the distance at a uniform rate of 9 miles an hour,

but has to take rest for 5 minutes at the end of every hour of cycling or he can go by a jutka doing 8·8 miles an hour. The jutka has no stoppage except to change horses at the end of the 20th mile which occupies 10 min. Find graphically which will be the quicker.

4. A race-course is circular, the track being 84 yards wide. Thrice round the circumference along the inner edge of the track is 2 miles. If two cyclists start abreast, one keeping to the inner edge and the other outer, where will the outer be when the inner has completed 6 circuits. ? Show their respective positions in a figure drawn to scale.

II

1. A money-lender advanced Rs. 3,600-0-0 to a merchant. The merchant paid $7\frac{1}{2}$ per cent interest, the interest to be added to the capital at the end of each year. At the end of the first year the merchant paid Rs. 1,200-0-0 towards principal and interest but became a bankrupt at the end of the second year and was able to pay only fourteen annas in the rupee. How much by way of interest did the money-lender receive ?

2. A stay-wire 15·6 ft. long is attached to an electric post at a height of 14·4 ft., from the ground, the other end being fixed in the ground. If the same wire be attached to a point in the post 1·92 ft., lower down, how much farther must the other end of the stay be from the foot of the post ?

3. A wholesale coffee merchant sold 84 viss of coffee at a gain of $11\frac{1}{9}$ per cent, 60 more viss at a gain of $16\frac{2}{3}$ per cent and a third lot of $69\frac{1}{3}$ viss at a gain of 25 per cent. Had he sold the whole at a uniform profit of 18 per cent, he would have got Rs. 4-14-0 more. Find the selling price per viss of coffee.

4. A regular hexagon is inscribed to a circle of radius r. Another regular hexagon is circumscribed to a circle of radius p. The areas of the two hexagons are equal. Establish the relation between p and r.

III

1. Draw a circle of radius 3·9 cms. Place in it a chord distant 1·5 cms. from the centre. Calculate its length. Also place another parallel chord on the other side of the centre, the length of the chord being 7·2 cms. Calculate its distance from the centre.

2. A merchant sold silks at a reduction of $11\frac{1}{9}\%$, cotton goods at a reduction of $13\frac{1}{3}\%$ and tweed at a reductien of $6\frac{2}{3}\%$ on the prices paid by him for these and realised respectively Rs. 697, Rs. 729-10-0 and Rs. 588-0-0 Find how much he would have gained if he had sold them at a uniform reduction of $8\frac{1}{3}\%$ on the prices paid by him.

3. A cricketer played 16 innings in Australia and had an average of 68·5 runs and by playing 10 more innings the same year in England he raised his average for the year to 88·5. Find his average runs per innings in England.

4. I motored straight to Trichy, distant 33 miles, at 18 miles an hour leaving the station P at 6-30 a.m. Having halted there for an hour I returned straight to P at 24 miles an hour. My neighbour left the station P at 8-15 a.m., motored to Trichy at 24 miles an hour, halted there for half an hour and returned at 30 miles an hour. Find graphically when and where we will be together.

IV

1. A field ABC in the form of an equilateral triangle is 3 chains each way. A point D is taken in AB at a distance of one chain from A and prependiculars DX and DY are dropped on the other two sides BC and AC respectively. Find (i) the perimeter and (ii) the area of the quadrilateral DXCY. Draw a neat figure to scale.

2. A publisher brings out 2600 copies of a book at a cost of Rs. 1,850. The author is to get 20 per cent of the published price. The publisher allows his retail book-sellers 20 per cent discount on the bill and counts 13 copies to the dozen. If when all the books are sold the publisher get a net profit of Rs. 1,300, what was the published price per copy ?

3. Twelve men agree to build a house in 45 days working 10 hrs. a day. On beginning work three are found unfit and the rest are obliged to work two hours a day less time. They thus complete a third of the work and take a few more men and continuing finish the work 5 days before the stipulated time. How many more men were taken?

4. A metal expands by 0·17 of its bulk when heated between two given temperatures. Find correct to 2 decimal places by how much of its bulk it contracts when cooled between the same temperatures.

V

1. A cyclist travels for x hours at a miles per hour; then for y hrs. at b miles per hour and finishes his ride at a speed of c miles an hour for z hrs. Find his average speed per hour.

If $x=4\frac{1}{2}$, $y=2\frac{1}{4}$, $z=\frac{1}{4}$ and $a=7$, $b=10$, find c if the average speed be 7 miles per hour.

2. A boy bounces a glass ball on the floor three times. At each rebound the ball attains a height only $\frac{3}{5}$ of its previous height. At the third rebound it rises $6\frac{3}{4}$ ft. What was the height from which it fell?

3. A boy plays a game of marbles. At the first game he lost $\frac{2}{5}$ of what he started with. At the second game he won 24 marbles. At the third game he lost a fourth of what he had at the end of the second game so that he went home with 4 marbles less than the number he started with. How many had he originally?

4. The parallel sides of a trapezium are 2·1 and 3·6 in. and the other two sides 1·5 and 1·8 in. Draw the figure and calculate the area.

VI

1. A walks at the rate of 4 miles an hour and goes a certain distance in 30 min. less time than B who walks the same distance at 3 miles per hour. What is the distance? Illustrate graphically.

2. Find the volume of a block of wood 12 yards long and 1 sq. ft. in section. What fraction of the length must be cut off so as to leave 27 cub. ft. of wood ?

3. An agent to a diamond merchant is paid a certain fixed monthly salary and also a certain discount on the value of sales effected by him during the month. In a month when he had sold goods for Rs. 7,850 he got Rs. 554 and got Rs. 584-0-0 when he had sold goods to the value of Rs. 8,600. What is his fixed monthly salary and what rate per cent discount is allowed him by the merchant ?

4. The cost of maintaining a cow is as follows : Hay Re. 1-2-0 per week; cake, gram etc. Rs. 6 per month. Wages for grazing and milking Re. 1-12-0 per month. Its yield is a measure of milk in the morning and three-quarters of a measure in the afternoon. The owner uses half-a-measure of pure milk every day, and adds quarter of a measure of water to every measure of pure milk and sells the mixture at $2\frac{1}{2}$ measures per rupee. How much will the owner save per month ?

VII

1. A survey map is drawn to scale of 16 in. to the mile. Find the size of a ten-acre field on this map. If this field is square, what is the length of the actual perimeter of the field ?

2. A horse dealer purchases two horses one for Rs. 240 and the other for Rs. 320. He wants to realise 15 per cent profit on the whole in selling them. If on the former he is able to get a profit of 20 per cent, what rate per cent profit must he get on the other ?

3. The front wheel of a carriage has a circumference of 13 ft. 6 in. and the back wheel 8 ft. 8 in. If in a certain distance, one turns 580 times more than the other, find the distance travelled.

4. A square field of 12 acres is laid out as a recreation ground. A space occupying a fifth of the field is reserved for spectators and occupies a belt of uniform width all round. How long is the side of the inner square ? Find the width of the space reserved for spectators. All in feet correct to the tenth of a foot.

VIII

1. A and B can do a piece of work in 12 days. They work for 2 days when B leaves. A is then assisted by C who works as fast as A himself and the work is then finished in $12\frac{1}{2}$ days more. In how many days can B alone do the work?

2. At an election each voter voted for two of the three candidates A, B and C. A got 63, B got 74, C got 45. How many voted for both B and C?

3. A train clears a bridge 10 fur. long in 3 min. 54 sec. and a man in the train has been observing the bridge for 3 min. 45 sec. Find the length of the train and its speed in miles per hour.

4. The answer to a problem as given by a boy was remarked as 12 per cent too small of the correct answer. The boy increased his answer by 12 per cent of itself and the result was £ 46-4s.-8d. too small still. What was the correct answer?

IX

1. One strip of carpet is 1ft. $10\frac{1}{2}$ in. wide and another strip is 2 ft. 3 in. wide. A square yard of the former costs 8 as. more than a square yard of the latter and a yard of the latter costs Rs. 4-2-0. How much does a yard of the former cost?

2. A hare makes 9 leaps in the same time as a dog makes 4, but the dog's leap is 7 ft. while the hare's is only 3 ft; how many leaps will the dog have to make before catching the hare, supposing the hare to have a start of 16 yards on a straight road?

3. To do a piece of work a contractor can employ two classes of workmen whose wages are in the ratio 17 : 13; if he employs the higher paid men who work the faster he pays £ 148-15s. in wages, being £ 10-10s. less than the lower paid men would cost him. Compare their rates of work.

4. A works for 6 days of 8 hours a day; B works for 5 hours on the first day and on each of the five subsequent

days 1 hr. longer than on the preceding day. A does as much in 4 hours as B does in 5 hours. The total sum paid to A and B for wages is Rs. 31-8-0. How much should each receive ?

5. The difference between the simple interest and compound interest on a certain sum for 3 years at 4% is £ 12-13s.-4d. What is the sum ?

X

1. The population of a district increases at 'Compound Interest.' The population at the beginning was 'p' and at the end of 'm' years was q. What will it be at the end of a further period of $2m$ years ?

2. A and B are two railway stations half a mile apart. A house H is 600 yds. from A. A train leaves A at 9 a.m. at 12 miles per hour. A man leaves the house at 8-55 a.m. and walking at 4 miles per hour is just in time to catch the train at B. How far is the house from B ? Locate the two stations and the house on a map drawn to scale.

3. I stood with my bicycle gazing at a procession which took 10 min. to pass me. Just then I mounted my bicycle and riding at 10 miles per hour reached the head of the procession in 5 min. Find the length of the procession and the rate it walked.

4. The following problems have to be worked mentally. Indicate your methods :

(*a*) How long will it take a cyclist riding 10 mls. per hour to catch a man who is $\frac{3}{4}$ mile in front running at $5\frac{1}{2}$ miles per hour ?

(*b*) A manufacturer marks his goods at a price that, after allowing a discount of 25 per cent on the marked price, would get him a profit of 20 per cent on his cost price. Find the marked price of an article costing Rs. 0-15-0 to the manufacturer.

(*c*) What sum of money decreased by 16 per cent of itself comes to Rs. 42-0-0 ?

5. A bookseller purchases second-hand books at a uniform rate of Rs. 0-6-0 each copy. He sells 10 per cent of the whole lot at Re. 1-4-0 a copy, 50 per cent of the remainder at Rs. 0-8-0 a copy and the rest at Rs. 0-2-0 each ; on the whole he gains Rs. 3-12-0. Find the number of books purchased by him.

6. Two boxes are made of teak wood planks $\frac{1}{2}''$ thick. The bigger is lidless and the smaller is closed. The external dimensions of these are $25''$ by $16''$ by $8''$ and $18''$ by $12''$ by $4''$. What would be the volume of space between the two boxes if the smaller be placed inside the larger ? What would be the cost of varnishing the inside and the outside of each box at 4 annas per sq. foot ?

7. A rising gradient of 1 in x means a vertical rise of 1 foot for every distance of x feet along the slope. A hill has a rising gradient of 1 in 18 for a distance of 600 yards and this is followed by a falling gradient of 1 in 200 to a distance of 450 yds. which is again followed by a rising gradient of 1 in 220 for a half-a-mile. Find the average gradient for the whole distance.

XI

1. A clock loses at the rate of 8·5 seconds an hour during the hot part of the day and gains at the rate of 5·1 seconds an hour during the cool hours. But on the whole it neither gains nor loses. How long in the 24 hours is it losing ?

2. A rectangular field is $1\frac{1}{2}$ times as long as it is broad and its area is $1\frac{2}{3}$ acres. In the centre of the field is a circular well of radius 15 feet. How far should one go from a corner along the diagonal before he reaches the rim of the well ?

3. By reducing the price of a book from $4\frac{1}{2}$s. to 3s. 8 d. the sale was increased by 50 per cent. If the author's royalty was $7\frac{1}{2}$ per cent on the price, what difference did it make to him in income per cent ?

4. A rectangular plate of metal is x in. long, y in. broad and z in. thick. Give an expression for its volume. Also find expressions for the weight and cost of the plate if the

metal costs a shillings per pound and weighs b pounds per cub. foot.

Give numerical values when $a=0{\cdot}5$, $b=540$, $x=8$, $y=6$ and $z=0{\cdot}01$.

5. A bookseller allows a regular customer 10 per cent discount off the marked price of a certain book. This book is marked Rs. 11-4-0 and on selling it to this customer, the bookseller makes a profit of $12\frac{1}{2}$ per cent. Find the cost of the book to the bookseller. If the book had cost him Rs. 0-6-0 less and the marked price had been 0-3-0 less, find what his percentage of profit would have been, discount being allowed as before.

6. A man who worked for 16 days earned £ 5-9s. in the last 5 days and thereby made the average of his daily earnings for the whole time greater by 4 shillings than the average for the first 11 days. Find his average daily earnings.

7. On a base 6 inches long describe a regular haxagon. What kind of figure is formed by joing alternate vertices? Calculate the area of the figure.

XII

1. A knot is a speed of 6080 ft. per hour. An aeroplane flying at 80 miles per hour is going in the same direction as a destroyer steaming at 35 knots. Find to the nearest furlong how far they will be apart in 3 minutes. The horizontal distance between them is required.

2. A ring slides along a low horizontal rail 10 yards long. A cow is tethered by a rope 21 ft. long to the ring. Find the area over which the cow can graze. Draw a diagram to show the area you calculate.

3. It was found in two consecutive years that the increase in the native population of a district was 8% and the decrease in foreigners was in the ratio 20 : 15; also the increase in the total population was 7%. Find the ratio of the strength of the native population at the first census to the strength of the foreigners.

4. A house has five floors. The rent of rooms in each floor is 0·75 of that in the floor below. If the rent of a room in the middle floor be Rs. 6-12 as. what will be the rate of rooms in each floor?

5. During a cricketing season a boy had played a certain number of completed innings in the last of which he made only 14 runs. If he had not played the innings or if he had played one more innings scoring 70 runs therein, his average in either case would have been increased by 1 run. What is his average and how many innings had he?

6. A man sets off at 6 a.m. walking to a neighbouring town 18 miles away at 4 miles an hour; after $1\frac{1}{2}$ hours he gets a lift and arrives in another $1\frac{1}{2}$ hours; he remains in the town 1 hour and bicycles back at the rate of 10 miles an hour. Find graphically:—

(i) The rate at which he travelled in the lift.

(ii) The time when he will reach his starting place back.

7. The floor of a garden house measures 10 ft. by 8 ft. The ceiling consists of two parts one of which is the horizontal terrace 10 ft. by 5 ft. with a front shed sloping from the top of the terrace to a height of 4 ft. The height of the terrace is 7 ft. What is the air-space in the garden house?

XIII

1. Evaluate $\frac{b^2x}{a^2-b^2}$ when $a=10{\cdot}5$, $b=8{\cdot}5$, $x=5{\cdot}5$.

2. ABCD is a square. The diagonals interesect at O. A circle centre C and radius CB cuts AC in K. If the side of the square be 4 in. calculate the areas correct to one-tenth of a square inch, of the triangle ABK and the circular half-segment BKO.

3. A journey of 100 miles is made without stopping. The first 33 miles is level, next 51 miles uphill and the remaining 16 miles downhill. The speed uphill is 25 per cent less and the speed downhill $33\frac{1}{3}$ per cent greater than the speed on the

level. If the total time taken be 4 hrs. $42\frac{1}{2}$ min., find the speed of the train on the level.

4. Answer *any two*—

(1) The angle of a sector of a circle is 144° and its radius is 3·5 cms. Find the area of the sector.

(2) An equilateral triangle circumscribes a circle of 18 in. diameter. Find its area.

(3) If a speed of x miles per hour is the same as a yds. in b min., establish a relation between x, a and b.

5. A branch society was able to invest Rs. 480 in the Central Bank at the beginning of each year. The bank allowed interest at $6\frac{1}{4}\%$ per annum on the amount at the beginning of each year. At the end of two years the directors of the branch resolved to award scholarships to the poor students to the extent of 6 annas on each rupee to the credit of the branch in the Central Bank. How much was available for scholarships ?

6. A man's gross income in 1902 was 20% greater than in 1901 and in both years £ 150 of his income was exempt from tax; the tax on the rest of his income being 14d. in the £ for 1901 and 15d. in the £ for 1902. Also the amount of income-tax paid for 1902 exceeded the amount for 1901 by £ 6-4-2d. What was the man's gross income in 1901 ?

7. Three places A, B, C on a railway are passed by a train at 9, 9-40′, 10-32′; another train passed A and B at 9-50′ and 10-16′, both trains travelling uniformly. At what time should the second train pass C ? If the first is travelling at the rate of $19\frac{1}{2}$ miles per hour, what is the rate of the second ?

XIV

Part I

1. P boxes each of which is a' by b' by c' internally are required to pack up a quantity of tea. How many boxes would be required if the dimensions were 1 foot greater each way ?

Find the No. if $P=500$, $a=4$, $b=3$, $c=3$.

2. An army marching, paces at 33 in. each step and takes 130 paces every minute. This army requires 1 hr. 40 min. to cover a certain distance. Find the time that might be saved if they march per minute 160 paces of 30 in. each.

3. PQRS is a square sheet of paper and T is the mid-point of RS. The paper is folded so that Q falls on T. If the crease meets QR in M, find the length QM. Given that PQ=8 in.

4. Two houses x, y are five miles apart. A leaves x at 12 noon and rides along the road which passes y at 8 miles an hour. B leaves y at 12·15 and walks along the road away from x at 4 miles an hour. When will A be 3 miles ahead of B? Illustrate graphically.

Part II

5. A cistern can be filled by 3 taps which take separately 3, $4\frac{1}{2}$, 6 hours to fill it. There is also a waste pipe. At 3 p.m. a man turns on the three taps and goes away without noticing that the waste pipe is on also. He returns at 4-38 p.m. when he finds that the cistern is just full. In how many hours can the waste pipe empty the cistern if full?

6. I purchased a site and erected a shed thereon. I also purchased an oil-engine and rice huller and I found that the building decreased in value by 5% of its value at the beginning of each year and the value of the plant also depreciated by 20% and calculating at this rate, at the end of two years, the site, shed and machinery was valued at Rs. 12,643-12 as. If I had originally invested Rs. 17,500 on both, find the price I paid for each.

7. If the exterior dimensions of a box, with lid, made of uniformly thick planks, are l, m and n inches and the thickness of the wood be t inches, construct a formula for the number of cubic inches of wood. If $l=18$, $m=10$, $n=6$ and the wood be 315 c. in., find the thickness of the plank of which the box is made.

8. Water flows into a bath through two 4 in. pipes at 8 ft. per second. The bath is 50 ft. long and 22 ft. wide. How long will it take to fill it to a depth of 8 ft.?

XV

1. (i) If I lose a % by selling an article for Rs. x, what did I pay for it ?

(ii) By substitution in the above result find the cost price when $a = 6\frac{1}{4}$ and $x = 15\frac{15}{16}$.

2. Work by the simplest method :—

(i) 1 yard = ·9144 metre. Express 99 yds. 1 ft. 6 in. in metres correct to the hundredth.

(ii) A selling price of £ 18-8s. gives a profit of 15 per cent. What profit per cent would be got by selling for £ 18 ?

(iii) If a man takes 2 hrs. 42 min. over a journey when he travels at 10 miles an hour, how long should he save when he travels at 15 miles an hour ?

3. A cyclist travels five-sixth of the distance from P to Q at 15 miles an hour and the rest he walks at 3 miles an hour; another cyclist cycles the whole distance at a uniform rate and both reach the destination at the same time. Find the rate of the latter.

4. A cylindrical tin holds 1 pint. A second tin is half the height of the first, but its diameter is $1\frac{1}{2}$ times that of the first. How much does it hold ?

5. A sports ground has a circular track of the same width all round. The area of the track is 2 acres and of the interior 10 acres. Find the width of the track.

6. A person buys a square field containing $22\frac{1}{2}$ acres for Rs. 10,000; and surrounds it with a compound costing Rs. 2-13-4 a yard. At what annual rental per acre must he let the field so as to get a return of $6\frac{1}{4}$% on his outlay ?

7. A and B can do a piece of work in 10 days, B and C in 15 days and C and A in 20 days. They all work at it for 6 days; A leaves and B and C go on together for 4 days more. If B then leaves, how long will C take to complete the work ?

8. How long will it take a battalion of 1204 men in fours to clear a bridge 240 yds. long? The distance between adjacent two fours is 54 in. and the normal rate of marching is 120 paces of 30 in. each per minute.

9. A tea merchant has a rectangular space for storing tea. It is $15\frac{3}{4}$ ft. long, $10\frac{1}{2}$ ft. broad and $9\frac{1}{3}$ ft. high. If the packets be all cubical and all of the same size, what is the largest size of each such packet and the number of packets in the space?

XVI

1. A cart wheel is 1·52 metres in diameter. Taking $\pi = 3{\cdot}142$, find at what rate in km. per hour, the cart is going, when this wheel turns 100 times in five minutes.

Taking 8 km. = 5 miles, express this speed in miles per hour to 3 significant figures.

2. (i) There are in a heap 68,900 copper coins; of these 49 per cent are quarter-anna pieces. The coins are roughly sorted into two heaps, one containing all the quarter-anna pieces which form 91 per cent of the coins in that heap. Find the number of coins in that heap.

(ii) If the copper coins were either quarter-annas, half-annas or pies and if the total value of all coins be Rs. 936-15-0, find the number of coins of each variety.

3. A, B, C, D are four stations on a straight running road. A to B = 60 yds., B to C = 40 yds. and C to D = 20 yds. A temple T. subtends a right-angle at AC and also at BD. Find its distances from the four stations and its shortest distance from the road ABCD.

4. A level cricket field contains 10 acres of ground. A plan of it is made and it is found that the plan covers 200 square inches. How long will the cricket pitch, a chain long, be on the plan?

5. If a model is made of the pavilion to the same scale and if a room in it contains 2400 c. ft. of space how many cubic inches of space will the room in the model contain?

R.B.A.N.M.S.H.S. (M) LIBRARY
B lore-42
206.
U.D.C. No: 513.15/Sub

6. A working 6 hours a day and B working 7 hours a day, together do a piece of work in a certain time; if A worked 7 hours and B 10 hours, they would do it in two days less. A is twice as rapid a worker as B. How many days does the work take?

7. A paddy merchant has two qualities of paddy. By selling the first variety at Rs. 8-10-0 per bag he gains 20 per cent. By selling the latter at Rs. 8-7-0 per bag he gains $12\frac{1}{2}$ per cent. But he mixes the two taking three of the former and two of the latter and then sells each bag at Rs. 8-2-0. Find his gain per cent.

8. A man borrows Rs. 100-0-0, to be repaid by instalments, and agrees to pay 12 per cent interest on what he owes at any time. He pays off Rs. 40-0-0 including interest at the end of each year, until a year comes when a less sum than Rs. 40-0-0 pays off the debt. What is this sum and what is the total of the repayments?

9. A dealer bought some sugar, half of it at 25s. 3d. per cwt., one third of it at 26s. $4\frac{1}{2}$d. per cwt. and the remainder at 27s. per cwt. How many cwt. did he buy and sell, if he made a profit of £ 14-4s. by selling all the sugar at 27s. 3d. per cwt?

XVII

1. In a certain town eggs are advertised for sale at $3x$ shillings a dozen and in another town they are being sold at x eggs for a shilling. What does one egg cost in each town? Find x if these two prices are the same.

2. A pipe whose cross-section is 2·5 sq. in. is delivering 100 tons of water per hour. If 1 cub. ft. of water weighs 62·5 lbs., find the velocity at which water emerges from the pipe.

3. In a regiment consisting of English, Irish and Scots, 50 per cent of the men were Irish and 32 per cent were Scots. After 250 Irish and 150 Scots were added to the strength, the proportion of English was 13·2 per cent. What was the original strength of the regiment and the number of men of each nationality?

4. Two persons start from the same place at the same time. One travels at $4\frac{1}{2}$ miles an hour and the other at $3\frac{3}{5}$ miles per hour. How far will they be apart in 4 hours if (i) both travel northwards, (ii) if one travels north and the other south, (iii) if one goes north and the other east ?

5. A boy is due at a certain place at a certain time daily. On Monday he starts at 8-30 A.M., and walking $3\frac{3}{4}$ miles an hour, he is 5 minutes late ; on Tuesday he starts at 8-40 A.M., and cycling at 10 miles an hour, is 5 minutes early. How far has he to go ?

Illustrate graphically.

6. A rectangular vessel is 15 cm. long, 14 cm. broad and 20 cm. deep. How many litres of water will it hold ?

If, when it contains water to a depth of 12 cm. a solid metal cyclinder 8·4 cm. in diameter and 10 cm. long is put in, how much will the water rise to the nearest millimetre ?

7. Two jars, each full, contain mixtures of wine and water, one in the proportion of 4 : 11 and the other 3 : 5. When the contents of the two are mixed, the proportion becomes 1 : 2. If the previous jar contains 20 gallons, what is the capacity of the second jar ?

8. (i) A piece of wire x in. long is cut into three parts and each part is bent into a circle. The first has a radius of $3\frac{1}{2}$ in., the second a radius of 3 in. and the third a radius of 4 in. Find x.

(ii) If the whole wire were bent into a circle, what would have been its radius ?

XVIII

1. (*a*) Arrange the digits 2, 3, 4, 5, 7 so as to form a number divisible by 132. The number must be the greatest possible. Explain your method.

2. A and B enter into partnership. B puts in Rs. 5,000 but after 3 months withdraws Rs. 1,250 and after another 6 months withdraws Rs. 1,250 more. At the end of the year their shares of the profits are equal. How much did A put in ?

3. At 9 a.m. a train left A for B and went at the rate of 4 miles in 14 minutes; at 9-15 a.m. another train left B for A and went at the rate of 5 miles in 16 minutes. If the trains meet at mid point of AB, find the distance from A to B.

4. In a quadrilateral ABCD, the sides AB, BC, CD are respectively 15, 20 and 24 inches long and the angles ABC and ADC are right angles. Find (i) the length of AC, (ii) the length of AD, (iii) the area of the quadrilateral.

XIX

1. A tradesman sold half his stock of a certain article at a profit of 50 per cent. He disposed of half the remainder by allowing 3d. in the shilling off the original selling price and took Rs. 50 for what was left. If he made altogether a profit of $15\frac{5}{8}$ per cent, what sum did he pay for his stock?

2. A grocer has two kinds of tea; he mixes 7 lbs. of the common kind with 2 lbs. of the better and sells the mixture at 2s. per lb. thereby gaining 20 per cent. His assistant mixes 2 lbs. of the common kind with 7 lbs. of the better and sells the mixture at 2s. a lb., thereby losing 20 per cent. Find the price of each kind.

3. An alloy of copper and zinc contains 73 per cent of copper. A second alloy of zinc and tin contains 54 per cent of zinc; a third alloy of tin and copper contains 12 per cent of tin. If these three alloys be mixed in quantities proportional to 1, 2 and 3, what percentage of copper, zinc and tin are there in the mixture?

4. I started from my house to a village and on reaching the village found a village time-piece indicating quarter past three. I halted there 25 minutes and drove back by a road one-fourth as long again at a rate twice as fast as I walked and reached home by 4 o'clock. If my clock is correct, by how much is the village time-piece wrong?

5. A destroyer is steaming through a channel 4 miles wide at 20 m. p. h. keeping one mile from one shore on which there is a fort whose guns have a range of 3 miles. Draw an accurate plan and find how many minutes she will be under fire.

If on the other shore, there is another fort opposite the first, whose guns have a range of 2 miles, show on your plan how she must steer to be under fire as little as possible and find this distance.

XX

1. (*a*) How many integers are there less than 1024 which are exactly divisible by 2, 3 and 5 and how many not divisible by 2, 3 and 5?

(*b*) ABC is a right angle. $AB=3$ in., $BC=4$; CE is drawn perpendicular to CA and $CE=12$ inches. Calculate the length of AE.

2. Two pint measures are filled each with milk and water. In one of them the ratio of milk to water is 8 to 1 and in the other 9 to 2. If the contents of both are emptied into a quart measure, what will be the percentage of water in the mixture?

3. Two taps can fill a bath in 8 and 12 minutes respectively and a waste pipe can empty it in 10 min. If the two filling taps are turned on for 6 min. and the bath is then just full, for how long must the waste pipe have been left open?

4. If 11 be subtracted from a certain integer, the remainder is the square of another integer and if 24 be added to the same number, the result is the square of the next higher integer. Find the integer.

5. *A* starts a business with a capital of Rs. 1,250; four months later he is joined by *B*, who adds Rs. 800 to the capital; still later *C* joins with a capital of Rs. 2,000; the first year's profits amount to Rs. 508. If *C*'s share be Rs. 80, when did he join?

XXI

1. Two trains each 60 yards long are running on parallel lines; when travelling in the same direction the faster takes 45 seconds to pass the other completely; when they are running in opposite directions they completely pass each other in 2 seconds, Find the speed of each train in miles per hour.

2. If the sides of a triangle be 5·1, 3·5 and 2·6 cms., find the length of the third side of another triangle whose area is equal to that of the given triangle and two of whose sides are 4·2 and 6 cms. Find also the altitude on the longest side.

3. There are three towns A, B and C. A and B are $4\frac{2}{3}$ miles apart; B and C $4\frac{1}{3}$ miles apart and A and C are 5 miles apart. Draw this triangle on a proper scale and construct part of a straight railway line which is to be equidistant from A and B. Mark on this line a station S as near to C as possible and calculate the distance CS.

4. A reservoir contains 40,000 gallons of water. A steady stream is flowing into it. There are a number of equal outlets. If 20 of these be opened, the reservoir is emptied in 20 min., and if 40 be opened, it is emptied in 8 min. Find the quantity per minute of water flowing into the cistern and of water flowing out by each outlet.

5. Two gentlemen A and B go out a-hunting. A fires 5 shots to B's 3, but A kills only 1 in 3 shots while B kills 1 in 2 shots. When B has missed 36 shots, which has killed more?

XXII

1. In a division sum the divisor is 429, the four right-hand digits of the dividend are 2414 and the remainder is 132. Find the three right-hand digits of the quotient.

2. The distance between two Railway Stations is 25 miles. On a map of the district this distance is represented by 6·25 inches. The district map occupies $\frac{7}{9}$ of the area of a sheet 7·9″ by 9 inches. Find the actual area of the country to the nearest square mile.

3. A works 7 hours a day for 6 days, B, 4 hours a day for 9 days and C, 5 hours a day for 7 days. If the wages paid to A and B together amount to Rs. 9-12-0, what do A, B and C, equally efficient, each receive?

4. A passsenger with 2 mds. 15 seers of luggage is charged Rs. 5, for luggage; but if he had included in his company four others travelling to the same place without auy luggage of their own, he would have been charged only Rs. 1-4-0. Find

the amount of luggage allowed free for each passenger and the charge per seer of excess luggage carried.

5. A train 60 yds. long passes completely another of length 40 yds. running in the opposite direction at 40 miles an hour in $2\frac{8}{11}$ seconds. How long will the first train take to pass a station 385 feet in length?

6. A man 6 ft. high stands at a distance of 28 ft. from a lamp post and his shadow is 12 ft. in length. Find the height of the post. If he moves 14 feet towards the post, what will then be the length of his shadow?

7. A closed rectangular metal box 32″ by 20″ by 18″ externally weighs 6 cwt. 1 gr. 20 lbs. when empty and 9 cwt. 24 lbs. 8 oz. when full of water. If the thickness of the metal be one inch, find the weights of a cub. ft. of water and a cub. in. of the metal.

8. A runs a mile race at a uniform pace of $5\frac{1}{2}$ yards a second; B runs for a certain distance at 5 yards a second, when finding himself 50 yards behind A, he increases his pace and wins by 10 seconds. By how much did B increase his pace?

9. A mail train leaves a station A for another B, 63 miles distant at 10 P. M. and runs at 30 miles an hour. A goods train leaves B for A sometime after and meets the mail at 11-45 P. M. and reaches A at 2-15 A. M. Find graphically (i) the speed of the goods train, (ii) the time of its departure.

10. Water flows through a cylindrical pipe of bore 2″ across into a cattle trough $16\frac{1}{2}$ ft. long, 11 ft. broad at the top and 8 ft. deep, the ends being (section) isosceles triangles. The rate of flow of water is 2 miles per hour. Find when the cistern will be full.

XXIII

1. An Englishman owns an estate in America bringing him an income of 1,230 dollars. The rate of exchange is 4·37 dollars to the £. If in England income-tax is charged at 4s.-6d. in the pound, find the Englishman's net income to the nearest penny.

2. The radius of a circle is r inches. Find in degrees the magnitude of the angle subtended at the centre by an arc a in. long.

Also what length of arc will subtend an angle of b degrees at the centre?

3. Two liquids weigh 1·72 gr. per c. c. and 1·27 gr. per c. c. A litre of the first is mixed with a quantity of the second and the mixture is found to weigh 1·52 gr. per c. c. How much of the second liquid was used? (1 litre = 1000 c. c.)

4. A well is dug in a rectangular garden 88 yds. by 84 yds. The well is 32 ft. deep. The section of the well is throughout a square of side 21 ft. If the mud removed is uniformly spread over the garden, by how much will the level of the garden be raised?

5. The dimensions of a swimming bath are: length 80 yds., breadth 15 yds. 2 ft., depth at deep end 8 ft. decreasing uniformly to 3 ft. 6 in. at shallow end.

Calculate the number of gallons of water required to fill the bath. (A gallon of water weighs 10 lb.; A c. ft. of water weighs 62·4 lb.)

6. An examiner in marking a set of papers gives the best candidate 279 marks and the worst 24 marks; he has to reduce the marks to such a standard that the best candidate gets 100 and the worst 15. Exhibit graphically how this can be done. Find the revised marks of papers originally securing 81 and 42.

7. PQRS is a rectangular piece of paper, PQ being 10 inches and QR being 6 inches. It is folded with a crease passing through P and cutting QR, so that Q lies on RS; find how far Q now is from R and S. Also find where in QR the other end of the crease is.

8. Draw accurately a triangle ABC having AB = 1·6 inches, BC = 3·2 inches and area 2 sq. inches Show that two triangles are possible. Measure the angle ABC in each case.

9. (i) Write down five consecutive odd numbers of which $2m+1$ is the middle number.

(ii) If x oranges for a shilling is the same rate as y pence per dozen oranges, find a numerical value for xy.

10. If 12 men, 16 women and 24 boys can do a piece of work in 25 days working at 8 hours per day, how many men must assist 32 women and 36 children in turning out another piece of work twice as large in 15 days of 10 hours each. Suppose that 3 men do as much work in the same time as 4 women or 6 children.

XXIV

1. (i) If a dollar = 4·3 shillings, find in pounds and the decimal of £ 1 correct to 3 places the difference between ·6325 of 10 dollars and £ 12-17s.-3d.

(ii) Reduce 2 kilogrammes 17 grammes to the decimal of 50 kilogrammes 425 grammes.

2. The population of a country increases at the rate of 10 per cent in the first 5 years and at the rate of 5 per cent in the next 5 years on the population at the end of the first 5 years. If the population is 69,300, what was its population 10 years ago ?

3. The sides of a rectangular field are in the ratio of 17 : 8 ; a boy walking at the rate of 12 furlongs an hour, goes round the field in 12½ minutes. Find the area of the field in acres. Find also the length of the diagonal.

4. The income-tax is raised from 6 pies in the Rupee to 8 pies in the Rupee and thereby a man has to pay a tax of Rs. 4-8-2 more though his income is Rs. 400 less now than before. Find his original income.

5. From a vessel containing one measure of milk, an ollock is taken out and replaced by water ; from the resulting mixture an ollock is again taken out and replaced by water. The same operation is repeated a third time. Find the ratio of milk to water in the final mixture.

6. (i) Draw a straight line 3·5 cms. long. Construct a regular hexagon on it. Find its area, and compare it with the area of the circle described about the hexagon.

(ii) A sector O A B of a circle has a perimeter of $42\frac{2}{3}$ inches, and the chord subtends an angle of 60° at the centre. Find the area of the minor segment.

7. ABCD is a quadrilateral field. AB = 10 yds., CD = 20 yds., and the diagonal AC = 26 yds., the angles B and D are right angles. Draw a figure to scale (1 in. = 10 yds.) and determine the area.

8. Water for the irrigation of a field of 18 acres is brought by a pipe 8 inches in diameter. Calculate the amount of water in 40 ft. of the pipe.

When the pipe is running full and at a speed of 40 feet per minute, how long will it take to deliver an inch of water over the whole field?

9. The distance from Pudukotah to Tirumayam is 12 miles. A man leaves Pudukotah for Tirumayam at 8 A.M. and walks at the rate of 4 miles an hour. He stops at Tirumayam for 20 minutes and returns to Pudukotah at 3 miles an hour. Another person leaves Tirumayam at 9 A.M. for Pudukotah and cycles at 8 miles an hour, stops at Pudukotah for 40 minutes and returns to Tirumayam at the same rate. Find graphically

(1) the distance between the two places of meeting and (2) the time that elapses between the first and second meeting.

10. The compound interest on a certain sum for 2 years is £ 381-12-0 and the simple interest on the same sum for the same period is £ 360. Find the sum and rate per cent.

Madras Secondary School Leaving Certificate Public Examination. 1911

1. Find graphically, what the remainder is when 189 is divided by factors.

2. A rectangle measures 10·05 cm. by 9·23 cm.; find the area of the rectangle, without directly multiplying these two numbers together.

3. Find the cost, to the nearest anna, of a school library as follows:—

No. of books.	Published Price of each	
	s.	*d.*
128	7	6
200	5	0
20	3	6
236	3	0
256	2	6
104	2	6 net
350	2	0
202	1	0 net

(*a*) 12 annas to the shilling.

(*b*) $6\frac{1}{4}$ per cent. discount allowed off the published prices except for the net books.

(*c*) Packing and carriage 2 per cent. of the published prices of the books.

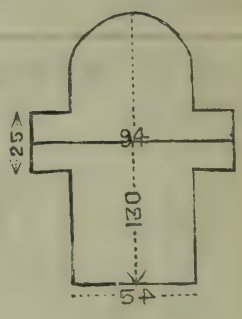
4. The following are the results of a recent examination.

Centre.	No. of candidates sent up	No. of passes
A	24	10
B	119	60
C	327	106
D	218	49
E	196	37
F	623	214
G	257	98
H	69	44

Find, correct to ·1, the percentage of passes for the whole examination; and give the percentage of passes at the most and at the least successful centres.

5. I bought a house for Rs. 6,500-0-0 ten years ago. I charge Rs. 40-0-0 a month for rent, and pay the house-tax (2*s.* 8*d.* a month) and the repairs (averaging Rs. 60 a year) myself. It has been let for an average of $9\frac{1}{2}$ months in every year; and the while it stood empty I had to pay a man Rs. 5·0-0 a month to took after it. At the same time I had a friend of mine who deposited Rs. 6,500·0-0 in a bank and had drawn annually interest at the rate of $4\frac{1}{2}$ per cent. per annum. Which of us has been benefited more from his investment and by how much?

6. This is the plan of a lecture hall (not drawn accurately to scale) one end terminating in a semi-circle. Find the area of the floor. The average height is 30 ft.; each person requires for health 200 cub. ft. of fresh air every hour: if a lecture lasts $1\frac{1}{2}$ hours and the air in the hall is not renewed, how many people ban be accommodated without injury to health.



At some school sports the mile-race is run on a perfectly circular course, the track being 8 yds. wide.

Four times round the course on the inner edge of the track is an exact mile. What is the length of the outer track?

8. A boy uses a badly-divided ruler supposed to be 6 in. long and to be divided into inches. As a matter of fact it is so divided that the first, second, etc., so-called inches are ·93, 1·03, 1·01, ·96, ·94, and 1·01 in. (each 'inch' being divided into ten equal parts). He measures a line and finds it according to his ruler, 3 ft. 4·6 in. What is the real length of the line?

9. A boy hires a bicyle by paying one rupee for the use of the bicycle plus eight annas for every mile that he rides:—

(*a*) Express the cost of hiring in terms of the number of miles ridden.

(*b*) Draw a graph representing the relation between the cost and the distance.

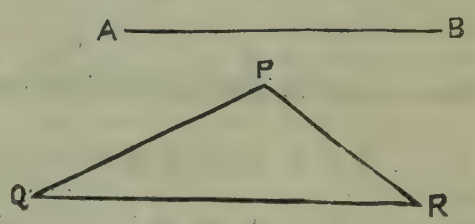
(*c*) From the graph find how many miles he can ride for Rs. 5-0-0.

10. The distance from Madras to Tuticorin is 440 miles. The following trains run :—

(*a*) Monday, Madras	dep.	6 p.m.	}	Represent these three journeys graphically in one diagram. With no help but the diagram say (*a*) how far each train is from Madras at 11 o'clock on Monday night, (*b*) at what time the train from Madras (No. 1) passes the trains (No. 2) and (No. 3) from Tuticorin, omitting stoppages and assuming each train to travel uniformly.
Tuesday, Tuticorin	arr.	4 ,,		
(*b*) Monday, Tuticorin	dep.	8 ,,		
Tuesday, Madras	arr.	6 a.m.		
(*c*) Monday, Tuticorin	dep.	11 ,,		
Tuesday, Madras	arr.	7 p.m.		

11. (*a*) Draw a line exactly equal in length to AB.

(*b*) Draw another line 3 times the length of AB.



12. Measure as accurately as you can, each of the angles and each of the sides of PQR and find its area.

13. On a black-board measuring 4 ft. by 3 ft. is drawn a triangle so that :—(1) one vertex is 18 in. from the top left corner of the black-board, and 24 in. from the bottom left corner; (2) another vertex is 24 in. from the top right corner and 18 in. from the bottom right corner; (3) the third vertex is 24 in. from the bottom right corner and the angle at this vertex is a right angle. Draw a plan showing the position of the triangle relative to the sides of the black-board. State your scale below the plan. (What is the length of the hypotenuse ?)

14. A goat is tied by a rope to a post 15 ft. from a long straight fence. The rope is such that the goat can reach with its mouth 23 ft. from the post. Along what length of fence can it nibble ? Draw to scale, choosing and stating your scale.

15. The full pension granted to an officer retiring from Government service is half his average salary for the last three years of his service; but in the case of an officer who enters service after an age of 30, the full pension is reduced

by $\frac{1}{40}$ for every year by which his admission into service exceeds 30. Express the pension of such an officer in terms of a full pension and of his age at admission into service.

Determine what pension a man who enters service at the age of 35 receives upon retiring, if his salary per mensem during his last 3 years of service is Rs. 375 for 10 months, Rs. 350 for Rs. 3 months, Rs. 370 for 8 months, Rs 380 for 9 months and 400 for 6 months.

1912

	Elementary Mathematics.										Total.	Per cent.	Rank.
Max ...	20	10	6	16	20	22	14	10	14	18	150		
A ...	14	8	3	13	13	16	12	4	10	12			
B ...	6	1	1	9	5	7	8	2	6	5			
C ...	2	2	0	6	1	4	5	1	3	2			
D ...	20	10	6	16	19	22	14	7	13	18			
E ...	13	3	2	12	12	14	11	3	9	11			
F ...	4	4	0	7	3	6	6	1		3			
G ...	1	5	0	5	0	2	4	1	2	1			
H ...	18	9	5	15	16	19	14	6	12	17			
L ...	*a*	4	1	11	*a*	11	10	*a*	8	8			
M ...	5	3	0	8	4	7	7	1	5	5			
N ...	7	2	1	10	6	8	9	2	7	6			
O ...	16	7	4	14	14	17	13	5	11	13			

1. In a table of 4 columns give—(1) the names (A, B & C) of these boys in alphabetical order ;(2) the total of each boy's marks ; (3) his percentage (in whole numbers) of the maximum ; (4) his rank (determined by his percentage).

In case of absence the mark in column (3) should be the boy's percentage of those maxima only for which he was present.

2 To celebrate the procession of Edward VII a certain town subscribed a sum of money which was spent as follows :—procession Rs. 57-0-0 feeding the poor Rs. 214-0-0 ; fire works etc. Rs. 136-0-0 ; sports Rs. 143-0-0 ; entertaining the children Rs. 184-0-0 ; local hospital Rs. 250-0-0 ; office expenses Rs. 36-0-0. If Rs. 145-0-0 had been subscribed last year and spent upon the same objects in the same proportion, how much (to the nearest anna) would have been spent upon each ?

3. (1) *Omit* (*stocks and shares*).

(2) Find the simple interest for 9 months and 20 days on Rs. 1,264-0-0 @ 10 as per Rs. 100-0-0 per mensem.

4. Allowing an average of 23 in. for each boy to stand in, if 198 boys are arranged in a circle what would be its radius ? If they are arranged in a rectangle of which each long side is double each short side what would be the length of its diagonal, in feet, correct to five significant figures ?

5. If this figure (A) is an accurate plan of the boundary of an estate, find the area of the estate in sq. yds. (Scale $\frac{1}{10}$ cm. to 50 yds.)

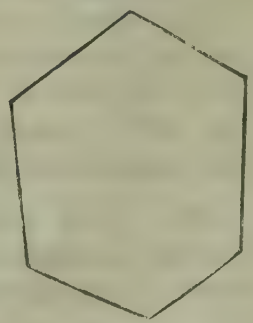


Fig. A.

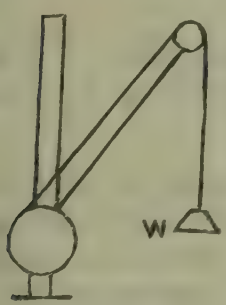


Fig. B.

6. This figure (B) is intended to represent a crane, the arm of which can be completely revolved around the central post, the bottom of the weight ('w') can be made to touch the ground and can also be raised 20 ft. above the ground. The distance of the vertical rope from the central post is

12 ft., and the radius of the central post is 6 inches. If the weight is moved to every possible position by the crane find the area of the surface over which a point on the bottom of the weight and vertically under the rope moves.

7. Draw a line 4·6 cm. in length and upon it describe an isosceles triangle having the angle at the vertex equal to 30°. Draw another triangle of the same form the sides of which are to the corresponding sides of the first triangle as 7 : 3.

8. The temperature of a patient taken every 3 hours was found to vary as follows :—

Monday	4	p.m.	100°·2	Tuesday	7	a.m.	100°·5
,,	7	,,	101°·4	,,	10	,,	100°·0
,,	10	,,	102° 8	,,	1	,,	100°·1
Tuesday	1	,,	103°·6	,,	4	p.m.	100° 3
,,	4	a.m.	1020·7				

Draw on squared paper a curve indicating these changes. From it deduce what was probably his temperature at midnight on Monday and at 8·30 on Tuesday morning.

9. If a certain substance weighs 4 tolas for every cubic inch, find the weight of a solid right circular cone of the substance, of which the height is 20 inches and the diameter of the base 14·6 inches.

10. Draw a circle of 3·3 cm. radius; insert in it a chord of 4·1 cm. long, and bisect the smaller arc of the circle.

11. Draw a graph showing the relation between so many rupees a month and its equivalent pounds a year (£ 1 = Rs. 15). From it deduce how many pounds a year are equivalent to Rs. 40 a month and also how many rupees a month are equivalent to £. 60 a year.

12. If a metre = 39·37 in. and a kilogramme = 2·2 pounds, express a pressure of so many pounds per sq. foot in terms of its equivalent in grammes per sq. cm.

13. The estimated cost of an irrigation project is 2 lakhs and it is expected to yield, after deducting for maintenance charges, a net return of 5·2 per cent; without such deduction, however, the return would be 6·4 per cent. Assuming the maintenance charges to be 12 as. per acre, find (1) the extent

of land proposed to be irrigated and (2) the water rate per acre proposed to be levied.

14. The time t in seconds of an oscillation of a pendulum is given by the formula $t = \pi \sqrt{\frac{l}{g}}$ where l = the length (2) of the pendulum. Find the length in centimetres of a pendulum which oscillates 89 times in a minute. $g = 981$; $\pi = 3{\cdot}142$.

15. The income and expenditure of a certain school are as follows :—School-fees, Rs. 12,672-12-0; fines, Rs. 9-7-0; stationery fees, Rs. 226-8-0; entrance fees, Rs. 56; library fees, Rs. 318-6-0; laboratory fees, Rs. 116-8-0; miscellaneous receipt, Rs. 27-7-0; salaries, Rs. 12,028-8-0; contingencies, Rs. 125-4-0; stationery, etc., Rs. 314-8-0; library, Rs. 367-3-0; class books, Rs. 63-8-9; furniture, Rs. 281-5-0; magazines etc., Rs. 213-6-0; laboratory, Rs. 187-8-0; prizes, Rs. 129-3-0; annual repairs, Rs. 253-7-0.

If the government pays a grant of half the deficit, find the cost to the proprietors per boy, there being 540 boys.

1913

1. (*a*)

Cities	Population	No. of females to 1,000 males
Madras ...	518,660	946
Madura ...	134,130	999
Trichinopoly ...	123,512	1006
Calicut ...	78,417	928
Kumbakonam ..	64,647	1064

From the above table, find (1) the total population of these 5 towns and (2) the number of males in each town.

(*b*) Find, correct to three significant figures, $0{\cdot}0923 \times 13{\cdot}215 \times 2{\cdot}654364$.

2. (*a*) What is Rs. 698-12-0 in English money if exchange is at 1*s.* $4\frac{10}{16}$*d.* per rupee ?

(*b*) A man placed Rs. 1,500 as a fixed deposit in a bank paying 5 per cent. interest, the interest being added to the capital every year. Four years afterwards the bank failed

and paid a dividend of 2 annas in the rupee. What did he get from the bank?

3. If a metre is 39·9708 in., find correct to the nearest foot, the difference between 83 kilometres and 51 miles.

4. Solve the following equations algebraically and check the result by means of a graph:

$$3x-\tfrac{2}{3}y=10\,;\ \tfrac{3}{4}x-1\tfrac{1}{3}y+1=0.$$

5. In a certain bicycle the hind-wheel revolves two and a half times for one revolution of the pedal. If the outside diameter of the hind-wheel is 28 in., express the distance travelled in terms of the number of revolutions of the pedal; and find the distance when the number of revolutions is 500.

6. (i) Of two cylindrical vessels the diameter of the second is double that of the first, and the height of the second is half that of the first. Compare the capacity of the second with that of the first. (ii) If each has some water in it and a stone is immersed first in the one and then in the other, compare the height by which the water would rise in the second with the haight by which it would rise in the first.

7. (i) Draw four parallel st. lines such that the distance between the first and second is 1 in., between the second and third $\sqrt{2}$ in., and between the third and fourth $\sqrt{3}$ in., finding $\sqrt{2}$ in. and $\sqrt{3}$ in. geometrically. (ii) Draw a st. line cutting these four parallels and making an angle of 45° with them. What length of this line is intererrupted between the second and the third parallels?

8. (i) Draw a triangle whose sides are 1·8 in., 24 in., and 3 in., respectively; give the measurement of each angle and state what the area of the circumscribing circle is.

(ii) Draw a rt. angled triangle and draw the square on each side; then show, by dotted lines and by instructions given below your figure, how to cut up the square on two sides and by super-position of the cut pieces upon the third square, how to prove that the area of two of the squares is equal to that of the third square.

9. *Omitted; Sphere and frustum of cone.*

10. For every acre of wet land a man pays a land revenue tax of Rs. 8; and for every rupee of land revenue he pays a local cess of 1a 6p. Draw a graph showing the total tax paid up on land varying in extent from 20 to 40 acres. What would be the total tax on 35 acres?

11. Find the cost of white washing a room which is 40 ft. by 18 ft. with walls 14 ft, high, allowing for half the area of the following openings; 2 doorways each 7 ft. $\times$ $4\frac{1}{2}$ ft; 4 windows, each $3\frac{1}{2}$ ft. $\times$ $4\frac{1}{2}$ ft. and 2 circular ventilators, each 2 ft. in diameter. The greatest height being 22 ft. Whit e-washing 2 as. 6 ps. per 100 sq. ft.

12. An open rectangular cistern of which the internal length, breadth and depth are as 4 : 3 : 2, is made of metal 1·5 cm. thick and 8 times as heavy as water. If the capacity of the cistern is 12,288 litres, find its weight in kilogram when empty.

13. A book-seller is allowed by a publisher 20% discount on the nominal price of a book and 5% on this last amount for cash. For every dozen books he gets an extra copy for nothing. The book-seller allows his cash customer 4 as. in he rupee off the nominal price. Find, to one decimal place, he book-seller's profit on cash sales.

1914

1, The following table gives the numbers of workers in Textiles in the Madras Presidency in the years 1901 and 911. Fill in the percentage column and the row of totals orrect to one decimal place.

Name of textile	No. in 1901.	No. in 1911.	Percentage of increase (+) or decrease (—)
otton (ginning, etc.)...	24,089	32,553	
otton (spinning) ...623,783		580,321	
ute ...	533	2,428	
ope ...	42,376	58,794	
ther fibres ...	7,886	9,252	
Total...			

2. Show by a rough approximation, without working the questions in detail, that the answers affixed to divisions (1) and (2) are obviously wrong and those affixed to divisions (3) and (4) are approximately correct.

(1) Find the cost per metre of cloth at 12 as, a yard, One metre = 39·37 in. (*Ans.* 12 as. 6 ps.)

(2) Find the income derived from the investment of Rs. 6,220 at 4% after paying an income-tax of 4 ps. in the rupee. (*Ans.* Rs. 249—4—7),

(3) Simplify: $30{\cdot}12 \times 19{\cdot}93 - (10{\cdot}01)^2$. (*Ans.* 500).

(4) Simplify: $\frac{19{\cdot}8}{201} \times \frac{25\frac{1}{14}}{398} \times \frac{4042}{1523{\cdot}5}$ $\left\{ Ans. \frac{1}{60} \right.$

3. The average of 'm' numbers is 'x' and the average of 'n' of those numbers is 'y.' What is the average of the remainder?

The area of the Madras City is 17,280 acres and the average population is 30·3 per acre. The area of the thickly populated divisions is 2804 acres and the corresponding average population is 135·3 per acre. Find the average population per acre for the rest of the city.

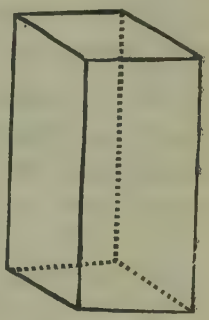
4. A milk-seller pays 5 as. per measure for the milk he purchases and adds water before selling it. He also defrauds by using, while selling, a false ollock-measure which is $\frac{1}{16}$ short of a true ollock. If he sells at $\frac{1}{2}$ anna an ollock and makes 12 per cent. profit, find the proportion of water to milk in this mixture. [A measure = 8 ollocks].

5 A manufacturer of an article sells it to a merchant at a gain of 'p' per cent on the cost of making. The merchant sells it for Rs. 'r' at a gain of 'q' per cent. What is the cost of making? Use your result to find the cost of making, when $p = 10$, $q = 12\frac{1}{2}$ and $r = 495$. Verify your result in any way.

6. A circular arch over a river rises 4 feet at its highest point above the level of the tops of the vertical piers. If the distances between the piers be 28 feet, find graphically or otherwise the radius of the circle of which the arch forms a part.

7. ABCD is a quadrilateral field; BC=20 yds., AD=24 yds., the diagonal BD=32 yds., the angles A and C are right angles. Draw a figure to scale (1 inch to 10 yds.) and determine the area.

8. How many squire inches of metal are required to make a tray of the shape shown in the diagram? The adjacent sides of the base measure 9 in. and 15 in. and the corresponding sides of the top measure 10 in. and 16 in. and the width of the strip making the sides is 3 in.



9. In order to find the diameter of a tube of uniform bore, some mercury was poured into it and the height of the column measured. The weight of the mercury was 19·72 grm., the height of the column 20·3 cm. What was the diameter of the tube? (A cub. cm. of mercury weighs 13·6 grams and $\pi = \frac{22}{7}$).

10. In 1911 the population of the Madras City was 551,660. Since then the birth rate per annum has been 42 per thousand and the death rate 39 per thousand; and the town has attracted people from outside at the rate of 17 per thousand every year. What will be the population in 1914?

11. The water-level in feet in the Red Hills lake on the 15th of every month for 12 months from April 1911 to March 1912 was 42·1, 40·5, 39·0, 37·9, 36·9, 36·6, 37·3, 39·1, 44·0, 44·3, 43·4 and 43·0.

Exhibit the variations in level by means of a smoothly drawn graph and find approximately when the level was (1) the highest and (2) the lowest.

1915

1. In a certain year the United Kingdom imported 61,325,694 cwt. of wheat valued at £22,934,523 from foreign countries and 41,568,705 cwt. of wheat valued at £16,837,425 from British possessions. Find, to the nearest penny, the value per cwt. of imported wheat (1) from foreign countries and (2) from British possessions. Also find, to the nearest nteger, what percentage of the total value of the imported

wheat is the value of the quantity imported from British possessions.

2. An English sovereign weighs 123·3 grains and contains 91·67 per cent of pure gold. Find the value, to the nearest tenth of a penny, of the gold in a sovereign at £ 3-17-6 for 480 grains.

3. I want to buy 20 yards of a certain wire which is 0·14 inch in diameter, but I find it is sold only by the pound. Calculate for me the weight of the wire which I want, given that iron weighs 470 lbs. a cub ft. Use the formula $v = 0{\cdot}785\, d^2 l$; where v is the volume in cub. inches of a piece of wire l inches long and d inches. in diameter,

4. At a show the following kinds of tickets are sold; green tickets at 0-0-9 pies, white at 0-0-3 pies, pink at 0-0-6 pies, and yellow at one anna. If 'g' green, 'w' white, 'p' pink, and 'y' yellow tickets were sold on a day, construct a formula for 't' the total collection in annas for the day. Use your formula to find 't' if $g = 360$, $w = 1760$, $p = 480$, $y = 80$. Also find 'g' when 't' $= 762$, $w = 920$, $p = 440$, $y = 72$.

5. A steamer goes 'a' miles up-stream in 'h' hours and 'c miles down-stream in 'd' hours. The stream flows 'e' miles per hour and the vessel could go 'f' miles an hour in still-water. Express 'a' and 'c' in terms of b, d, e, f. If $a = 16$, $b = 2$, $c = 18$, $d = \frac{8}{2}$ what are e and f?

6. A ladder 12 ft. long leans against a wall making with it an angle of 25°. Draw the ladder in position representing 1 ft. by $\frac{1}{6}$ in. Then draw the ladder in a new position with its lower end 2 ft. farther from the wall and find by measurement, how much lower the top of the ladder will then be.

7. Take any straight line and mark a point A at a distance of 4 cm. from it. Now find another point B which is 3 cm. from A and 3 cm. from the line. Find also a point C 2 cm. from A at which the line AB subtends a right angle. Find, by measurement, the distance of C from the first line.

8. A hay-shed consists of a rectangular space 32 ft. long, 6 ft. high and 26 ft. wide surmounted by a covering roof whose section is a semi-circle. Calculate how many tons of hay can be stored in it. if a ton of hay, occupies 300 cub. ft.

9. A merchant sells silk of two qualities which cost him Rs. 4-0-0 and Rs. 3-4-0 per yard respectively. The selling price of the latter is two-thirds that of the former, but the quantity sold is double. He gains 25 per cent. on the whole. Calculate the selling price per yard of each.

10. In a certain factory the machinery was valued at Rs. 32,500-0-0. If it depreciates each year at the rate of 8 per cent of the value which it had at the beginning of the year, find, to the nearest rupee, what its value would be after 4 years.

11. I live three-quarters of a mile from my railway station and take 15 minutes to walk the distance. I am accustomed to meet at a certain point some children going to school in the opposite direction. The children take 30 minutes to the mile. One day when I am at my usual time, I am 220 yards farther on when I meet them. How much later will the children arrive at school that day than on ordinary days, provided they keep their ordinary pace ?

Draw three graphs on one diagram to show the position of the children and myself at any time on ordinary days and on the special day mentioned, taking the usual meeting place and time as origin.

12. Passengers on the railway are allowed a certain weight of luggage free and the rest is paid for at 5s. 7d. per cwt. If a traveller with luggage weighing 256 lbs. had to pay 8s. 4½d. for his luggage, find the weight of luggage allowed free and draw a graph connecting the amount of luggage carried and the charges paid.

1916

1. The following table is a classification of the number of people in thousonds supported by agriculturists and actual workers in agriculture for the years 1910 and 1911. Find to the nearest integer the increase or decrease per cent. in the figures for 1911 as compared with those of 1910 under each head.

Description	Supported by Agriculturists		Actual workers in agriculture	
	1910	1911	1910	1911
Non-cultivating land owners ...	34	30	23	19
Cultivating land-owners ...	461	512	426	484
Non-cultivating tenants ...	6	2	4	1
Cultivating tenants ...	225	167	207	151
Farm labourers ...	279	284	340	345

2. On March 1st 1913, a person borrowed from A Rs. 1,450 at 8 per cent. simple interest, and lent the sum on the same day to B at 8 per cent. compound interest; if both the transactions were closed on March 1, 1915, find his gain.

3. *Omitted*: *Stocks and shares.*

4. A school grants its games-association Rs. 216-0-0 a year, which is distributed among its three branches Tennis, Football and Badminton, in the proportion of 14 : 6 : 1. The tennis branch is 14 strong and each member pays a subscription of Rs. 2-0-0 per half year. If the branch pays Rs. 6-0-0 a month to the pickers and spends Rs. 32-0-0 per annum on repairs to the court, find how many balls a month at Rs. 12-0-0 per dozen the branch can supply itself with, so as not to work at a loss.

5. If a book-seller fixes his prices so as to include a profit of 30 p. c. on the cost price and offers a reduction of 10 p. c. on the published price for cash payments, find his gain per cent. If the cost price of 34 copies of a book be Rs. 50, what is his average gain per copy when all are sold for cash ?

6. *Omitted*: *Sphere.*

7. A cast-iron cylindrical weight is 18 in. in diameter and has a slot 2 in. wide and 10 in. long. Find correct to 2 places of decimals its thickness in inches when its weight is 100 lbs. (one cub. in. of cast-iron weighs ·26 lb.)

8. The following table gives the power P lbs. to be applied in order to move the weight (W lbs.) for a certain machine.

W	50	100	200	300	400	500
P	106	122	152	184	216	246

Draw a graph showing the relation between P and W, and find to the nearest integer the value of P, when W = 350 and of W when P = 158.

9. If a person buys 'p' dozen mangoes at 'a' as. per dozen and 'q' dozen mangoes at 'b' as. per dozen, and 'r' dozen mangoes at 'c' as. per dozen, and sells two-thirds of the whole lot at 'd' as. per dozen and the rest at a annas per dozen, find the profit. If the profit is Rs. 4-6-0 when $p=12$, $q=5$, $r=13$, $a=20$, $b=12$, $c=10$, find 'd'.

10. Solve: $2x+3y=12$; $0{\cdot}5x-y=4$.

Compare your answer with the results obtained graphically.

11. Construct a quadrilateral ABCD having AB = AD = 4 cm., AC = 8 cm. and CB = CD = 6 cm. Measure BD and the angles B and D.

12. Draw an equilateral triangle and a regular hexagon so as to lie between the same parallels and compare the areas of the two figures.

1917

1. (1) The H. C. F. of three numbers is 7 and their L.C.M. is 12012. Two of the numbers are 364 and 84. Find the least value of the third number.

You are given that $461010 = 77 \times 5987\frac{1}{7}$. Show how you can write down (correct to 5 places of decimals) the quotient when 0·046101 is divided by $(14 \times {\cdot}055 \times {\cdot}001)$ without actually going through the ordinary process of division.

2. The following statement gives the figures under each head of contingent charges, both estimated and actual, for 1913—1914 :—

Items	Estimated			Actual		
	Rs.	A.	P.	Rs.	A.	P.
Printing ...	15,650	0	0	10,595	6	0
Stationery ...	12,550	0	0	6,610	2	0
Travelling Expenses ...	10,630	0	0	12,939	7	0
Postal and other charges...	6,670	0	0	7,483	9	7

Items	Estimated Rs.	A.	P.	Actual Rs.	A.	P.
Examination charges ...	3,450	0	0	3,362	10	1
Contribution to the library.	5,550	0	0	6,434	8	0
Cost of University Lectures.	6,600	0	0	5,550	0	0
Total ...						

Fill in the row of totals and find by what percentage correct to one decimal place the total of actuals had fallen short of the total of estimated charges.

3. Two partners invest Rs. 2,700 and Rs. 1,500 respectively in their business and arrange that 40 per cent of the profits should be divided equally between them and the remaining profits treated as interest on the capital. If one partner's share of the profits is Rs. 90 more than the other's share, what is the whole amount of the profits ?

4. A man buys a field for Rs. 3,750 and lets it at a rent of Rs. 150 payable at the end of each year. The rent is invested at 5 per cent compound interest per annum. At the close of 3 years he sells the field for Rs. 4,000 and draws out the accumulated rents and interest. Find the total he will have and the annual percentage (simple interest) he makes by the whole transaction.

5. A railway track starts from station A with a gradient of 1 in 200, (*i.e.*) a vertical raise of 1 yard in 200 yards measured along the track. The gradient remains the same for $\frac{1}{2}$ mile and is followed by rising gradients of 1 in 150 for $\frac{3}{4}$ mile, 1 in 120 for $\frac{1}{2}$ mile, level for 1 mile and falling gradients of 1 in 110 for $\frac{1}{2}$ mile, and 1 in 230 for $\frac{3}{4}$ mile, when station B is reached. If station A is 179 feet above sea-level, find, to the nearest foot, the elevation of station B

6. The average heights of a man and a woman and their corresponding weights are given in the following table :—

Height	5′0″	5′2″	5′4″	5′6″	5′8″	5′9″	5′10″	6′0″
Average weight of a man in pounds ...	126	139	145	155	162	169	178	
Average weight of a woman in pounds	103	112	126	139	152	156	...	...

Draw graphs in one and the same figure showing the relation between the average height and weight for each sex. Find from your graph the difference between the average heights of a man and a woman who each weighs 10 stones, and the difference in weight if they are each 5 ft. $6\frac{1}{2}$ in. in height.

7. *Omitted* : *Sphere.*

8. A child is instructed as follows :—" Think of a number ; double it ; add 11 to the result, multiply the sum by 3, subtract 12, divide the remainder by 3, give me the answer." Find a simple rule by which the number first thought of can be readily deduced from the answer given by the child.

9. A and B engaged in play : when A had lost Rs. 20-0-0 he had only one-third of the money which B had ; but by continuing to play he not only won back his Rs. 20-0-0 but also Rs. 50-0-0 more with it and then found he possessed half as much again as B. With what sum did they respectively begin ? Reduce the conditions of the problem to simultaneous equations in two unknowns and solve the problem.

10. A is the centre of a circle of 5 cm. radius, and B is the centre of a circle of 2 cm. radius, CD is a direct common tangent to the two circles, and touches them at C and D respectively. If CD is 4 cm. long, find the distance between the centres. Draw a neat figure to scale.

11. Divide a st. line AB 6·4 cm. long, internally at X and externally at Y, in the ratio of 3 : 5. Verify the result of your construction by measuring the lengths of the segments.

Also show that they satisfy the formula $2/AB = 1/AX - 1/AY$.

12. Show by a carefully drawn diagram how you will verify by paper cutting the truth of the proposition that the square on the hypotenuse is equal to the sum of the squares on the other two sides of a rt. angled triangle.

1918

1. The fee income from the secondary department of a school in a certain month is given in the adjoining table.

Find	Form.	Strength.	Amount. Rs.	As.
(1) The average fee paid by each boy in the whole department; and	VI	79	414	0
	V	80	404	4
	IV	78	383	8
(2) The percentage of the I Form collections to the whole income,	III	76	240	0
	II	74	191	3
	I	125	326	8

2. A merchant bought at Narsapur 40 candies of paddy at Rs. 38-0-0 a candy and sent the same to Tanjore, paying Rs. 10-0-0 towards boat-hire as for as Nidadavole and 17 times as much for railway charges from there to Tanjore. His agent sold the whole quantity at Tanjore at Rs. 2-4-0. a kalam. Find the amount of gain or loss to the Narsapur merchant, if he paid his agent a commission of 5 per cent on the sale proceeds. 1 kalam = 24 Madras measures. A candy = 800 seers, each of which is $\frac{2}{3}$ of a Madras measure.

3. The following is a rough extract from a railway guide.

Trains from Madura.

Distance from Madras in miles.	Stations.		Boat mail to Ceylon.
348	Madura	*departure*	11-45
448	Rameswaram	*arrival*	16-30

Trains to Madura.

Distance to Madras in miles.	Stations.		Boat mail from Ceylon.	Rameswaram Express.
448	Rameswaram	*departure*	9-45	12-30
348	Madura	*arrival*	14-30	19-30

Represent the motions of the three trains graphically. From the graph find when they are 40 miles from Madura and when and what distance from Madura the Boat mail from Madura meets the other two trains (N.B.—*Time is calculated for 24 hours from mid-night to mid-night*).

4. On each page of an atlas the border lines are, $7\frac{1}{2}$ in. lengthwise and 6 in. breadthwise. The map of the Indian

Empire is drawn to a scale of 300 miles to an inch and occupies $\frac{4}{9}$ of the space within the border lines. Find the area of the Empire in sq. miles. On another page of the same atlas with similar border lines, there is the map of the Madras Presidency, whose area is 153,000 sq. miles, excluding the Native States occupying $\frac{17}{72}$ of the space enclosed by the border lines. Find the scale to which this map is drawn.

5. In the Post Office, War-Loan certificates were issued on the following terms:—For a payment of Rs. 7-12-0 a certificate was issued which entitled the holder to get Rs. 8-1-0, Rs. 8-14-0 and Rs. 10-0-0, at the end of one, three and five years respectively. What rate per aunum, simple interest, does it come to in each of the three cases? Given also that the certificate holder was entitled to receive Rs. 8-7-0, and Rs. 9-6-0, at the end of 2 and 4 years respectively; show graphically how the money grows during the five years.

6. A cylindrical granary with a conical top is 14 ft. in diameter on the inside. The wall is 11 ft. high, and the total height to the top is 14 ft. It was full of grain. Half of it was sold at Rs. 5-12-0 a bag and the other half at Rs. 5-4-0 a bag. Find the amount realized, given that a bag of grain measures 8·25 cub. ft.

7. Describe a regular octagon on a straight line 2 cm. long and find its area by any method.

8. At a public examination in the Madras Presidency, 'x' candidates who had taken Optional Mathematics scored in Elementary Mathematics an average of 'm' marks and the remaining 'y' candidates for the examination scored an average of 'n' marks. What was the Presidency average in the subject? If $x = 2{,}500$. $y = 6{,}428$, $m = 53$, $n = 30$, find the Presidency average.

9. A village postman attached to the Post Office at P has to go to 5 villages A, B, C, D and E and return to P. A is 3 miles due-north of P; B, C and D are on the eastern side of the road from P to A; B is 8 miles from P and 6 miles from A; C and D are 5 and 6 miles respectively from P on a straight road PCD which is at rt. angles to PB. E is 3 miles from P, its position being to the west of the road PA and the

roads PE and AE being at rt. angles to each other. Draw a diagram [scale 1 cm. = 1 mile] and indicate the shortest route for the postman. What is the length of his circuit?

10. (1) Construct a quadrilateral ABCD, given that AB = 3 cm. DA = 4 cm., $\angle A = 120^\circ$, $\angle C = 70^\circ$ and AB is parallel to CD. Measure BC.

(2) The middle points of the sides of a scalene triangle are joined so as to form a new triangle. What fraction is this of the given triangle? Explain from a figure how your answer can be shown to be true experimentally by superposition.

11. The distance from Madras to Ootacamund by railway is 358 miles, part of which is ordinary railway and the other part mountain railway. The second-class fare over the former is 9 ps. per mile and over the latter 1 a 9 ps. per mile. If the total fare be Rs. 18-10-6, find the length of the mountain railway.

12. A reservoir which supplies water to a town has two in-lets whose diameters are 30 in. and 16 in. respectively, through which water pours in throughout day and night. Water is to be taken into the town through 6 pipes, all of uniform diameter. But they will remain open only from 5 a.m. to 9 p.m. daily, What should be the diameter of each of the latter, if the quantity conveyed to the town every day is to be equal to the daily supply into the reservoir, assuming that the rate of flow is the same through all the 8 pipes?

1919

1. In form I of a certain school there are four divisions.

Division.	Strength.	Total marks.
A	34	1372
B	35	1339
C	36	1489
D	37	1275

The adjoining table gives the strength and the total marks gained by the students of each division in a certain subject.

Find correct to one decimal place, the average mark for the whole form, and ascertain which division gets the highest average and which the lowest.

2. A merchant cleared his goods by selling them at educed prices. He sold certain goods whose catalogued sale rice was Rs. 760-0-0 at a reduction of 15 per cent, another et of goods whose sale price was Rs. 880-0-0 at a reduction f $12\frac{1}{2}$ per cent, and the remaining goods whose sale price vas Rs. 480-0-0 at a reduction of 25 per cent. He however ained in all 11 per cent on his original cost price. Find the riginal cost price and also what percentage he would have ained had he not made any reduction in the catalogued scale rices.

3. ABCD is a quadrilateral field in which AB=198 yds., BC=264 yds., and CA=330 yds., D is equidistant from A nd C and at a distance of 214·5 yds., from the diagonal AC. 1) Draw a plan of the field to a scale of 1 cm.=33 yds., 2) Find the area of the field in acres.

4. The distance from P to Q along a road is 65 miles. person A starts from P at 7 A.M. and travels to Q on his notor-cycle at the rate of 10 miles an hour, taking rest for 0 min. at the end of every hour of cycling. B starts from at 8-45 A.M. and goes to Q on his motor-car at a uniform te of 15 miles an hour. Represent their journeys raphically.

From the graph, find (1) when each of them will reach , (2) when and where B will overtake A and (3) by what stance they will be apart at 9-15 A.M.

5. A man borrows Rs. 1,800-0-0 at 8 per cent per annum I. and forthwith lends it as follows :—

(1) Rs. 800-0-0 to A at $10\frac{5}{8}$ per cent per annum S.I.

(2) Rs. 600-0-0 to B at 10 per cent per annum C I., and

(3) the remainder to C at $12\frac{1}{2}$ per cent per annum for e first year and 12 per cent per annum for the seeond year, e interest being compounded with the principal at the close the first year. At the end of 2 years, he collects the nounts due from A, B and C and pays his dues to his editor. How much does he gain ?

6. (1) Show by a geometrical construction how a length hich is $\sqrt{3}$ times a given length may be found.

(2) Describe a regular hexagon on a straight line 1·5 in. long and find its area.

7. A stone road-roller should be 4 ft. long, and should weigh 4 tons 8 cwts. What should be its diameter given that the weight of the stone is 441 lb. per cubic foot ?

8. There are some beggars consisting of men and boys. If the former be given Rs. 0-5-6 each and the latter Rs. 0-3-6 each a sum of Rs. 12-10-0 will be required. If each man is given 6 ps.less and each boy 6 ps. more, the total sum required is 2 as. less. Reduce the above conditions to equations and find the number of men and of boys. Represent the equations graphically and verify the graph.

9. A garden is 240 yds. long and 180 yds. broad. A moat 5 yds. wide and 2 yds. deep is dug close to it on the outside all round, and the earth dug out is spread evenly over the garden. (1) Find in inches correct to one decimal place, the height by which the level of the garden will be raised thereby.

(2) A certain contractor undertook to finish the work in 30 days and employed 36 men. At the end of 10 days, only 1 ft. 6 in. of the depth of the moat had been dug all round. How many additional men should he employ from the 11th day to finish the work in the stipulated time ?

10. A certain boy took a circular piece of card-board having a radius of 17·5 in. and made an angle of 144° at the centre. He then cut out and removed from it the sector piece containing the angle 144°, and made the bounding radii of the remaining piece coincide. What shape did he get? Calculate its height.

11. A merchant buys m maunds of coffee seeds at Rs. a per viss and n maunds at Rs. b per viss and mixes them. He sells the mixture at a uniform price and gains c % on his total outlay. Find the selling price of each viss of the mixture.

If $m=4$, $n=5$, $a=1\frac{1}{4}$, $b=1\frac{1}{2}$, $C=12\frac{1}{2}$, find the selling price of the mixture per viss.

12. In a certain meadow there is a hut whose ground plan is a square each side of which is 28 ft. A cow is tethered to a post at one of its corners by a rope 35 ft. long. Find the area that the cow has for grazing.

Re-Examination 1918

1. The strength of Form VI in a certain school is 105. The form average in Elementary Science was exactly 31 in a certain year. The boys scored marks thus in the subject :— 15 boys 54 marks each ; 22 boys 45 marks each ; 28 boys 38 marks each ; 25 boys 35 marks each ; and 13 boys 24 marks each. Of the remaining two boys A and B, A scored 20 marks more than B. How many marks did each of them get ? Also find their rank.

2. A grocer wants to mix 80 ℔s. of tea worth 15 as. a ℔. with some tea worth Re. 1-4-0 a ℔., so that by selling the mixture at Re. 1-3-0 a ℔. he may gain 20 per cent. on his outlay. How many pounds of the superior sort should be taken to form the mixture ?

3. In a 100-yards race A beats B by 20 yards and C by 8 yards. If B and C run over the same course of 100 yards, find who will win and by how many yards to the nearest integer. Verify the result graphically.

4. An open rectangular box is to be made out of a rectangular piece of card-board 21 in. × 10·5 in. by cutting out 4 equal squares at the corners of the rectangle and folding up the 4 rectangles that result so as to form the vertical sides and the ends of the box. If the ends of the box are squares, find the cubical contents of the box. Draw a plan of the card-board to a scale of 1 cm to 1 in. as it will look after the square corners are removed and before the rectangles are folded up. Also find the maximum number of such card-board boxes as can be packed in a cubical box whose edge on the inner side is 2 ft. 4 in. (The thickness of the card-board to be neglected throughout.)

5. According to the catalogue of a London firm, the cost of the books that are to be bought for a High School in Madras is £ 60, of which 25 per cent is marked nett. In the case of the books so marked the packing is free. For the remaining books a discount of 20 per cent is allowed but £ 1—4—0 is charged for packing. The freight to Madras for the whole consignment is £ 2-16s. A Madras book-seller undertakes to supply the books marked nett at Re. 1 a shil-

ling and the rest at 14 as. a shilling. Which is more profitable to get the books from London or to buy them in Madras, and by how many rupees ? [current market rate £ 1 = Rs. 19.]

6. Men, women and children are employed in a factory in the proportion of 1 : 2 : 3, and the wages of a man, a woman and a child are as, 6 : 3 : 2. When the number of men employed is 50, the total weekly wages of all the hands amount to £ 225. Find the weekly wages paid to a man, a woman and a child respectively.

7. Describe a quadrilateral ABCD with the following data :—AB = 8·5 cm., BC = 7·5 cm., AC = 6 cm., CD = 5 cm. and $\angle$ D = 90°. Find its area correct to two decimal places. If it represents a field drawn to a scale of 1 cm. = 30 yards, find the area of the field in sq. yds. correct to one decimal place.

8. A person borrows a certain sum of money at $13\frac{1}{2}$ per cent per annum simple interest promising to repay the amount at the end of 4 years and 6 months. But the loan had to be extended for a period of 1 year and 6 months more. Thereupon the creditor demanded not only that the interests that had accumulated till then should be added to the principal but also the rates should be raised to 16 per cent per annum for the period extended. On account of this the person had to pay Rs. 107-5-4 more than he would have paid, had the sum continued at the simple interest for the whole period at the original rate. Find the sum borrowed.

9. The following table gives the population in thousands, of two towns A and B at the beginning of each of the years specified :—

Year.	1835	1845	1855	1865	1875	1880	1890
A	24·4	26	29·5	34	40	43	50
B	34	36	38·4	41·1	43	44·8	46·7

Draw graphs on the same diagram to represent the above, and estimate thereform the population of each of the towns at the beginning of 1870. In which year was the population approximately the same in both towns, and what was it ?

10. An Indian merchant arranged to buy tweed in France at 4·4 francs per metre. The cost of getting the same to India averages 0·1927 francs per metre, If he sells at Rs. 3 per yard, find his gain or loss per cent. [Re. 1 = 1·68 francs; 1 metre = 1·0935 yards.]

11. The length of a park is to its breadth as 4 : 3 and its area is 77 acres $88\frac{3}{4}$ square yards. Find the length of its diagonal in yards.

12. To walk 1 mile A takes 'm' minutes and B 'n' minutes. (1). What distance does A walk more than B in one hour? (2) Find in terms of 'm' and 'n' what time A takes to walk 3 miles more than B. (3) Express to the nearest minute in what time A walks 3 miles more than B, when $m = 16$ and $n = 21$.

1920

1. The sea-borne trade of the Madras Presidency for the year 1918-1919 shows that the value of foreign imports under 'Tobacco' raw and manufactured was Rs. 188, 652, for 1918-19 and Rx. 113,000 for 1917-18, the average for the preceding 4 years up to 1916-1917 inclusive being Rx. 49,394. Find (1) the increase per cent. in the value of imports in 1918-1919 over that in 1917-1918, and (2) by how many rupees the value of imports in 1918-1919 was in excess of the average value for the preceding 5 years, (*i.e*) up to 1917-1918 inclusive. [1 Rx. = Rs. 10.]

2. The cross-section of the canal running across the Godavari at the Gunnavaram Aqueduct is a trapezium 24 ft. at the top and 19 ft. at the bottom, the depth being 6 ft. If the slopes are of equal inclination, draw the cross-section to scale of 1 cm. = 2 ft. Measure the angle at which the sides are inclined to the bottom of the canal. Given that the length of the aqueduct is 810 yds., find in cub. yds. the maximum quantity of water that can be contained in the whole length of the aqueduct and also in how many minutes a boat 15 yds. long and going down the canal at $3\frac{3}{4}$ miles an hour, will pass the aqueduct.

3. To find the height of a certain tower a surveyor fixes a pole vertically at a distance of 80 yds. from it, the height

of the pole above the ground being 15 ft. On going 5 yds. from the pole and away from the tower, he sees the tops of the pole and of the tower in the same straight line with his eye. Find the height of the tower, given that the height of his eye is 5 ft. from the ground.

4. In the catalogue of a certain merchant the selling prices are given as shown in the accompanying table. He usually allows a discount of 5 per cent on silks and 10 per cent on checks. Owing to the War conditions he has raised his prices on all his goods by 20 per cent but allows still the same rates of discount on the increased prices. A customer buys 6 yds. of Tassur silk, 7 yds. of Nagur silk, 8 yds. of Turban silk, 14 yds. of Calicut check and 16 yds. of Holland check. What sum has he to pay the merchant?

Goods.	Price per yard. Rs.	A.	P.
Tassur silk.	4	11	0
Nagur silk.	3	2	0
Turban silk.	2	5	6
Calicut check.	1	9	0
Holland check,	0	12	6

5. A person bought two horses for different prices. By selling the first at a profit of 10 per cent and the second at a profit of 15 per cent, he gained 13 per cent on the total cost price. Had he sold the first at a profit of 15 per cent and second at a profit of 10 per cent he would have got Rs. 6 less on the whole. Find the cost price of each of the horses.

6. A road runs from P to S passing through Q and R. PQ is $10\frac{1}{2}$ miles and QR 7 miles. A starts from P at 6 a.m. and walks to S at a certain uniform rate, halting at Q for half an hour and at R for one hour. B starts from P at 7 a.m. on his cycle, his rate of cycling being 7 miles an hour. He passes A at 7-45 a. m. and goes on to R, where he stops for one hour. He returns to Q, where business detains him for an hour and a half. He then goes straight to S, which he reaches at 4 p.m. Find the distance from P to S, A's rate of walking, and the time when he reaches S. Represent the above graphically, and find from the graph when and where A and B will be together.

7. Describe an acute angled triangle ABC, given that AB = 3·2 in., BC = 2·6 in., and $\angle A = 50^\circ$. Measure AC and the angle C. Find the area of the triangle in sq. inches by

any method. If it represents a field drawn to a scale of 1 in. = 1 furlong, find the area of the field in acres.

8. When performing a certafn experiment in Science the temperature at the end of 10, 20, 30, 40, 50 and 60 seconds was found to be 15°, 30°, 43°, 56°, 58° and 45° respectively, it being observed also that 60° was the maximum reached, Draw a smooth curve, showing the changes in the temperature and find from it the temperature at the end of 25 seconds and also the time when the temperature was 50°.

9. If 'm' men can do $1/n$ of a piece of work in p days, find an expression for the number of men required to do the whole work in q days. Find the number when $m = 15$, $n = 4$, $p = 12\frac{1}{2}$ and $q = 20$.

10. When a certain weight was cast, it was found to weigh 1·84 lbs. more than was intended. Thereupon a cube with an edge of 1·5, was scooped out from the bottom of it. But thereby the weight was diminished only by 1·08 lbs. It is proposed to diminish the rest by scooping out a cone with a bottom circumference of $5\frac{1}{2}$ in. What should be the depth of the cone?

11. One litre of water weighs 1 kilogram, and one litre of pure milk 1·32 kg. A person bought 12 litres of milk and found it weighed only 12·288 kg. Find in cub. cm. the quantity of water in the milk. (1 litre = 1 cubic decimetre.)

12. A War Savings Certificate costs 15s. 6d. and is worth at the end of the fifth year £1. After that period one penny is added to it every month and at the end of the tenth year from the commencement a bonus of 1s. is added to the total value of the Certificate. What rate of simple interest per annum does this work out for the whole period of 10 years?

Forty-eight English men employed in India saved each a sum of Rs. 2-8-4 daily from March 1st to September 2nd both inclusive; and with the total sum thus saved arranged to buy War Savings Certificates in England. How many certificates did they buy in all, and what total sum would they get in England by converting the certificates into cash at the end of 10 years after their purchase? [Re. 1 = 1s. 4d.]

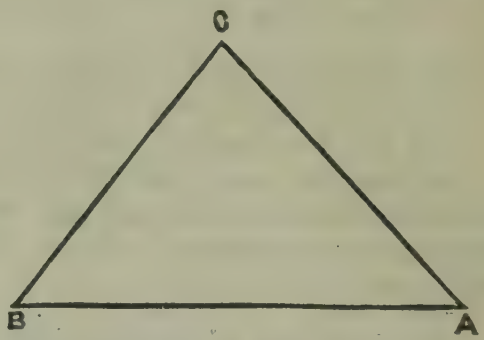
1921

1. A metre is a ten millionth part of the arc of a meridian of the Earth from the Equator to the Pole. The earth's semi-circumference measured along a meridian is 10,800 nautical miles. Find the number of feet in a nautical mile, if one metre = 39·370 inches.

2. How far is the following statement correct?—Three measurements are necessary and sufficient to prepare an exact copy of a given triangle.

Measure the sides correct to the nearest tenth of an inch and the angles correct to the nearest degree of the given triangle ABC.

Construct a triangle PQR of the same shape as ABC but of perimeter 9·6 in. (*N.B.*—The data required for the construction of triangle PQR should all be obtained geometrically,)



3. AB is a diameter of a circle, whose centre is C. The circle is folded so that the points A and B are brought together at the centre C thus causing two creases. Show that the points A, B and the four ends of the two creases are the corners of a hexagon. Calculate the area of the hexagon to the nearest hundredth of a square inch, if the radius of the circle is exactly 2·4 inches. Check by drawing an accurate figure.

4. Here is an extract from a statement of Educational Progress in the Madras Presidency for three years.

	1914-15	1915-16	1916-17
Total population	41,404,405	No change.	No change.
Total Scholars in all Institutions	1,542,955	1,615,159	1,661,012
Grand total of expenditure in thousands of rupees	19,353	20,652	21,688

Find from this statement (1) the ratio of the number of scholars to the total population for 1915-16 expressed as a percentage, (2) the increase per cent. in the number of scholars in 1916-17 over that of 1914-15 and (3) the increase in the average expenditure per scholar for 1916-17 over that for 1914-15. Answer to the nearest anna.

5. When sovereign was selling at Rs. 18-12-0, a gentleman purchased a watch chain made of 12 sovereigns (including a wastage of $6\frac{1}{4}$ per cent.) The making-charges were 14 as. per sovereign. A few days later he had to sell it, when the price of the sovereign fell to Rs. 16-4-0. The purchaser would take the chain on its net weight only, and would pay only 75 per cent. of the making-charges per sovereign on the net weight of the chain. What did the gentleman lose by the transaction?

6. A High School Co-operative Society was supplied by a Bombay Firm with Mathematical books at a discount of $33\frac{1}{3}$ per cent and History books at a discount of 40 per cent. off the published prices. Subsequently it was found that the Society would have paid $2\frac{1}{2}$ per cent. of the published price less, if all the books had been purchased from a Madras book-seller, who offered a uniform discount of $37\frac{1}{2}$ per cent. What percentage of the purchases. calculated at the published prices, was of Mathematical books?

7. The Secretary of a Chit Fund was authorized to buy a cash box. Every year of use was supposed to decrease the value of the box by $12\frac{1}{2}$ per cent. of what it was worth at the beginning of that year. At the end of 2 years, the Fund was dissolved and the box was sold by auction for half its original value. By how much per cent. was this less than its value as calculated at the above rate of depreciation?

8. At the time of the German reverse (1914), a body of Germans began their retreat at the rate of 24 kilometres a day, from a place 36 kilometres distant from the Allies Battle Front. The Allies began their pursuit a day later at the rate of 32 kilometres a day. After three days' marching, they were delayed in their pursuit for a day to construct a bridge across a river; they then continued their march for three

days more and were again delayed for half a day to repair another bridge blown up by the enemy. After how many days from the beginning of the retreat were the Germans overtaken? Draw a graph to illustrate the movements of the armies. Find from the graph (1) how far the armies were apart seven days after the beginning of the retreat; (2) the time when the armies were 32 kilometres from one another.

9. A circus tent is in the form of a cylinder surmounted by cone. The cylindrical portion of the tent is of diameter 96 ft., the height of the top of the tent is 36 ft. from ground, and the height of the cylindrical part 16ft. Find the total area of the canvas required for the tent. Answer to the nearest square foot. [$\pi = 3{\cdot}1416$.]

10. The alloy of which the rupee is made consists of silver and copper melted together in the ratio of $r : 1$. The alloy is worth a rupees per lb. and pure silver s rupees per lb. Express the value of copper per lb. in terms of a, s and r. What does copper cost per lb. if $a = 36\frac{3}{4}$, $s = 40$ and $r = 11$?

11. For an entertainment to be given to the Principal of a College on the eve of his transfer, the students of the B.A. class agreed to raise among them a certain sum, levying a uniform rate of subscription. Intermediate students joining them subsequently, the subscription per student was reduced in the ratio of 7 : 4 although the estimated expenses were increased by 50 per cent. Compare the strength of the B.A. and Intermediate classes. From your result find the strength of the College, given that the number of students in the Intermediate class was 182.

12. The following table gives a series of soundings (measures of depth) taken across a river 42 yards broad at a ford.

Distance in yards from a bank.	0	5	8	10	14	16	19	23	26	30	32	35	38	42
Corresponding depth in feet.	0	2·8	4·4	5·0	7·2	8·0	10·2	9·8	8·4	7·3	6·0	4·8	3·1	0

Draw a diagram to represent a section of the river at a ford. From it find (1) the probable depth in the middle of

the stream, (1) how far a man who will be safe up to a depth of 5 ft, 2 inches can venture into the river from either bank without danger.

1922

1. Here is an extract from Indian Railway Statistics:—

Year.	Miles of State Railways.	Gross earnings in Rupees.
1903	21,131	36,00,82,035
1912	25,125	61,65,07,005

Calculate:—(1) The earning capacity of the Railway per mile in the two cases, correct to the nearest rupee. (2) The percentage of increase in that capacity for the period 1903-12, correct to the first decimal.

2. Two persons standing at P and Q, 300 yards apart on a straight sea-shore, wish to find the distance of a boat B from the shore. They observe the angles BPQ and BQP to be 50° and 70° respectively. Obtain the distance of the boat from the shore.

3. Assuming that 15 cm.=5·9 in., draw a graph to convert inches into centimetres and *vice versa*. From the graph, get (1) the number of inches (to the nearest tenth) in (i) 4 cm., (ii) 10 c.m., and (2) the number centimetres (to the nearest m.m.) in (iii) 2·8 inches, (iv) 4·5 inches.

4. The following is one of the rules of a Sangeetha Sabha:—

'Each member shall pay Rs. 1-4-0 every time he attends a performance *or* pay an advance annual subscription of Rs. 15 and also 10 annas at each performance'—(performances being weekly). A member X selects the first method of payment, and another member Y the second method. Both attend the performances regularly. After how many performances does Y gain an advantage over X? Verify the solution of the question by drawing two graphs (in the same figure) to show the amounts paid by X and Y.

5. In connection with a street improvement scheme, a Municipal Corporation purchased the whole block of houses on one side of the street and the ground (708 ft. × 108 ft.)

on which they stood. The houses alone cost Rs. 2,54,000, and the land cost Rs 45-0-0 per *kuli* (144 square feet.) The houses were pulled down and the materials auctioned away for Rs. 95,000-0-0. The street (708 feet long) was then widened by 12 feet and the remaining land was sold at Rs. 185-0-0 per *kuli*. Find the net cost of the improvement scheme.

6. From a rectangular sheet of brass 32 in $\times$ 20in a circular piece of diameter 20 inch. is cut out and the remaining part is melted and beaten into a rectangular piece of the same shape as the original sheet and of the same thickness. Find its length and breadth to the nearest inch. [$\pi = 3\cdot1416$]

7. Pure gold is said to be 24 carats fine. Mint gold contains 22 parts of pure gold to every 2 parts of alloy, and is hence said to be 22 carats fine. The gold nibs of Waterman Fountain pens are 14 carats fine. To make such nibs 89 ounces of pure gold and 48 ounces of mint gold are melted together with a certain quantity of alloy. Find the quantity of alloy.

8. At a 'Grand Clearance Sale' a firm say that they have reduced their catalogue prices 20 per cent, and also allow their customers 5 per cent off their bills for immediate cash payments. If their profits even after such reductions on cash sales come to 14 per cent, with what rate of profit in view were the original catalogue prices fixed?

9. I purchased a bungalow two years back for Rs. 50,000-0-0 and spent 10 per cent of this sum to effect certain alterations and reapairs. The bungalow has remained unoccupied till now, and during this interval I reckon 5 per cent per annum compound interest on my outlay. If I want to realise a profit of 20 per cent on the total amount, at what price should I sell the bungalow now?

10. The owner of a lead mine collected 216·15 tons of stuff from which lead was to be extracted. It contained x per cent of lead. After washing, in which process no lead was lost, the stuff was found to contain y per cent of lead:

show that $\frac{y-x}{y}$ of 216·15 tons was washed away.

Find the quantity of lead obtained from the stuff, if $x = 15'9$ and $y = 87'45$.

Names of continents.	Areas in squire miles to the nearest tenth of millions.
Asia	17·0
Europe	3·3
Africa	11·4
Australia	3·3
North America	8·0
South America	6·8

11. Draw a circle of radius 3 inches and divide it into six sectors whose areas are proportional to those of the six continents given in the adjoining tabular statement. (1) Indicate in your figure the values of the angles of the sectors to the nearest degree. (2) Enter neatly the names of the continents in the corresponding sectors.

12. Two cylindrical rollers of radii a feet and b feet lie side by side on a level ground, touching each other along their lengths. Express in terms of a and b the distance between the lines along which the rollers touch the ground. Find the distance if $a = 2'25$ and $b = 1'69$.

1923

1. The following statistics are taken from the Report on Public Instruction in Madras for 1920-21 :—

Year.	Grants from Provincial funds to Schools under private management.	Local Board Schools.	Municipal Schools.
	Rs.	Rs.	Rs.
1919-20 ...	40,54,293	33,39,703	6,53,466
1920-21 ...	42,96,756	34,61,324	4,31,880

Find—(1) the grand total of grants-in-aid in 1919-20 and 1920-21 :—(2) the increase per cent. in grants for 1920-21 as compared with those for 1919-20 for Local Board Schools; (3) what percentage the grants in 1920-21 for private institutions was of the total grant for the same year ?

2. (1) If a piece of iron plate 2·1 metres long, 1·13 metres broad and 2·3 cm. thick weighs 425 kilograms, find to the nearest gram the weight of a square metre of sheet iron 2 mm. thick.

(2) Two cyclists start abreast at 3 o'clock to race on a circular track. If one goes round in 3 min. 12 sec. and the other in 3 min. 30 sec., find when they will again be riding abreast past the starting point. Find also the number of complete circuits they will then have made.

3. A tradesman marks certain goods 30 per cent above cost price; he allows cash customers a discount of 12 per cent and credit customers a discount of 5 per cent; five-eighths of his goods thus marked are sold for cash and the rest on credit. When the whole stock has been sold and paid for, what is his percentage profit?

4 The Boy Scouts of a High School have a Savings Bank of their own and one of them had a balance of Rs. 6-0-0 at the Bank on the 1st January, 1922. At the beginning of February and of each alternate month following, he deposited Rs. 3-0-0. In the middle of April when the school closed, he withdrew Rs. 5-0-0 for his journey. If interest be allowed at $6\frac{1}{4}$ per cent per annum, what interest should be added to his account at the end of June 1922, each month being calculated as one twelfth of a year?

5. A Railway contractor purchased 360 tons of cement at Rs. 95-0-0 per ton two years before it was actually required and in conveying the cement from Madras to the nearest Railway Station, paid a railway freight of Rs. 9-14-0 on each ton. The unloading and conveying charges amounted to 4 annas for a bag of cement. (10 bags of cement weighed one ton.) On the above outlay he reckoned 5 per cent per annum C. I. During the two years when the cement lay idle, he had to stock it in a building paying a rent of Rs. 25 per mensem. When after two years the cement was wanted, he charged the Railway a higher rate and thus realised a profit of 60 per cent on the total amount spent. Find to the nearest rupee, the rate he charged for a ton.

6. A contractor employs 20 men working 8 hours a day in order to finish building a house in 25 days. At the end of 14 days only one-third of the work is finished. He engages more men and all his men now work 9 hours a day. What is the least number of additional men that he must engage, if the work is to be done by the specified time?

7. Two boys *A* and *B* had their heights measured on the first day of six consecutive years and their measurements are given below:—

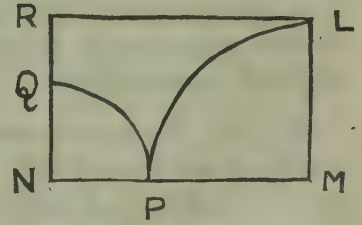
	1916	1917	1918	1919	1920	1921
A	3' 0"	3' $4\frac{1}{2}$"	3' $7\frac{3}{4}$"	3' $10\frac{3}{4}$"	4' 1"	4' $2\frac{3}{4}$"
B	3' 2"	3' $3\frac{1}{2}$"	3' $5\frac{3}{4}$"	3' $8\frac{1}{2}$"	3' $11\frac{3}{4}$"	4' 4"

Draw, on one diagram, graphs to illustrate their growth, and find the dates when they were of the same height.

8. If the speed of an aeroplane is v miles per hour, find its average speed from *A* to *B* and back, if the wind is blowing all the time from *A* to *B* at u miles an hour. Find the average speed of the aeroplane if $v = 60$ and $u = 5$.

9. I stand on the road 6 feet from a lamp-post and notice that the end of my shadow just reaches a point at the foot of a wall. Find, by drawing to scale (1 cm. = 1 ft.), the distance of this point of the wall from the lamp-post, if the light is 10 ft. above the ground, and my height is 5 ft. 6 in. Find this distance also by calculation.

10. In the accompanying figure LMNR is a rectangle; a quadrant of a circle is drawn with M as centre and ML as radius, meeting NM at P; another quadrant with N as centre and NP as radius meets RN at Q. P being between N and M, and Q P being between R and N. If the curved path LPQ from L to Q is 20 ft. less than the path LMNQ and 10 ft. less than the path LRQ, find the sides of the rectangle, [$\pi = 3{\cdot}1416$].



11. (*a*) Draw a right-angled triangle with equal sides and with hypotenuse equal to 2·3 inches. On the other side of

the hypotenuse construct a square. Compare the area of the triangle with that of the square. (*b*) If the figure thus drawn represents the end view of a haystack whose breadth is b ft. and length l ft., what is the volume of the stack in cubic feet? Calculate the volume in cubic feet when $b = 20, l = 50$.

12. A boy fills with moist sand a cylindrical bucket which measures internally 12 in. in diameter and 16 in. in height. He empties the bucket and builds a conical mound with the sand on a base whose diameter is 18 in. Find the height and volume of the mound and the area of its curved surface.

1924

1. The following statistics taken from the census of 1921, give the population in thousands, of Hindus, Muhammedans and Christians in six districts :—

	Population in thousands.		
—	Hindus.	Muhammedans.	Christians.	Total.
Guntur (M) ...	1,514	131	153	
North Arcot ..	1,893	118	36	
Tanjore (M) ...	2,105	130	89	
Trichinopoly (M)	1,746	63	92	
Ramnad ...	1,521	116	85	
Tinnevelly (M)	1,600	109	192	

(1) Find the total population for each district (horizontally) and for each community (vertically). (2) Express the Muhammedan population in each of the districts marked (M) as a percentage of the total population of that district correct to two significant figures, and state which of them has the highest percentage.

2. (1) Find in pounds and ounces (correct to the nearest tenth of an ounce), the weight of a cubic foot of water, given that 1 metre = 39·371 in., 1 kilogram = 2·2046 lb. and 1 cubic metre of water weighs 1,000 kilogram.

(2) A railway company increased its railway fare by one-half and again increased it by three-fourths of its new value. Find the original cost, to the nearest anna, of a ticket which after the two increases costs Rs. 19-4-0.

3. (*a*) The capital of a Co-operative Publishing House is fifteen thousand rupees: one-third of it is borrowed from a Bank at 6% and the remainder is held in shares. The working expenses of the House are 40% of the gross receipts in a year. Find what the gross receipts must be in order to pay the shareholders 9% at the end of the year.

(*b*) Three vessels, each capable of holding 32 gallons, contain mixtures of wine and water. In the first, which is half-full, the quantities of wine and water are equal; in the second which is three-quarters full, there are 9 gallons of wine; and in the third, which is full, there are only 4 gallons of wine. If the second is now filled up from the third, and then the first filled from the second, how many gallons of wine and water will be found in the first vessel?

4. For a certain foot-ball tournament. twelve teams (each consisting of six players) entered, paying an entrance fee of Rs. 10 each. During each of the first four days of the tournament the spectators who numbered 500 on an average were charged 2 as. each and on the fifth day, when the finals were played, the attendance was half as much again as on any previous day and tickets were sold at 4 as. each. The committee in charge spent 30% of the total income in fencing the ground, 25% of the remainder for ground-rent and Rs. 30—7—0 on miscellaneous charges. They further set apart Rs. 200 for Reserve Fund after purchasing a silver cup for the winning team and six silver medals for the runners-up. the cost of each medal being one-twelfth of that of the cup. Determine the cost of the cup and of a medal.

5. A dealer offers to sell a motor-car for Rs. 5,000 cash or for twelve monthly instalments of Rs. 500 each, the first being payable at once. Calculate the rate of simple interest charged on the supposition that the Rs. 5,000 invested at that rate for 11 months gives the same amount as the total of the amounts of the instalments invested at the same rate.

6. Among the elected members in a certain Legislative Council, the ratio of the ministers' party to the rest was 5 : 2. Eighteen members left the ministerial party and joined the opposition and consequently the ratio was reduced to 26 : 23. Find the total number of elected members.

7. The following table gives the time of sunrise and sunset at a certain place from July to December, 1923 :—

Date.	July 1.	July 15.	Aug. 1.	Aug. 15.	Sep. 1.	Sep. 15.	Oct. 1.	Oct. 15.	Nov. 1.	Nov. 15.	Dec. 1.	Dec. 15.	Dec. 31.
	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H. M.
Sunrise	5 47	5 50	5 54	5 56	5 58	5 58	5 58	5 59	6 2	6 8	6 16	6 23	6 31
Sunset	6 39	6 39	6 36	6 31	6 21	6 12	6 0	5 51	5 44	5 39	5 40	5 45	5 53

(1) Plot graphs (in two different diagrams) showing for the given period (*a*) the time of sunrise, (*b*) the duration of sunshine, on successive days. (2) Deduce from the graphs the time of sunrise on November 22, and the duration of sunshine on August 8.

8. A man standing 12 yards from a river bank observes a post on the further bank directly opposite to him. He walks 30 yards parallel to the bank and then walks directly towards the post reaching the bank after walking 15 yards. Find by drawing to scale (1 cm. to represent 3 yards), the breadth of the river, assuming the banks to be straight. Find the distance also by calculation.

9. A surveyor gives the following measurements of a quadrilateral field ABCD (having no re-entrant angle) : AB = 1,980 links, BC = 1,920 links, AD = 1,700 links, $\angle$ BAC = 35°, $\angle$BAD = 61°, C and D being on the same side of AB. Draw a plan of the field to a scale of 1 in. for 400 links stating the steps of your construction. Find the area of the field in acres given 100 links = 22 yards.

10. A shop-keeper uses a badly made balance so that a body really weighs $a + b$ Q lb. when the balance shows only Q lb., a and b being numbers which are the same for all weights. If the balance shows 1 lb. for a real weight of 1·1 lb. and 2 lb. for real weight of 1·9 lb., what are the values of a and b and what will the balance show for a real weight of 2 lb. ? Draw a graph to show the relation between the real weights and the weights shown by the balance.

11. A canal whose cross-section is a trapezium is 8 feet deep, 18 feet wide at the surface and 12 feet wide at the bottom. Find the area of the cross-section and the number of gallons of water that pass any spot in an hour when the canal is full and water flows at 2 miles per hour. (Given one cubic foot of water = 6·25 gallons.)

12. A right circular cylindrical log of teak is 12 ft. long and of diameter 14 inches. Find its volume and curved surface. If it is planed down to the least amount necessary to form a prism whose cross-section is a regular hexagon, what would be the volume of the prism in cubic feet, given $\pi = \frac{22}{7}$ and $\sqrt{3} = 1{\cdot}73$? What percentage (correct to an interger) of the whole log would be wasted in planing down?

1925

1. The following table shows the population in thousands of five Indian provinces according to the census taken in the years 1911 and 1921 :—

	Population in thousands.	
	1911	1921
Bengal	48,483	46,696
Madras	41,405	42,319
Bombay	19,626	19,348
United Provinces ...	46,807	45,376
Punjab	19,579	20,685

Find, correct to one decimal place (1) the percentage of increase or decrease of the population in each of the first three provinces (2) the percentage of increase in all the five provinces taken together.

2. Three men A, B and C have together completed a piece of work for which they receive Rs. 64-14-0. A has worked for 4 days of $10\frac{1}{2}$ hours, B for 11 days of 7 hours, and C for 6 days of 9 hours. How much money ought each to receive?

3. A goldsmith undertook to make a jewel casket out of certain quantities of gold and silver, together weighing 140

ounces and costing £234—4—0. Instead of using the quantities of gold and silver agreed upon he interchanges them. If gold costs £3—17—6 and silver 5 s. 6d. per ounce, find by how much the value of the casket has been reduced.

4. A clerk's salary was £ 80 for each of the first three years. Then it was raised at the rate of £ 10 a year for 12 years, after which it remained stationary. When he retired from work, he found that his average salary per year had been £ 174—10—0. How many years did he work?

5. Exactly three years ago a man borrowed Rs. 1,890 from a bank at $6\frac{1}{4}\%$ per annum. At the end of a year he paid the interest for that year and a part of the loan, amounting altogether to Rs. 500. Similarly he paid Rs. 700 at the end of the second year. What sum must he now pay to clear off the debt? (Answer to the nearest anna.)

6. Three cyclists, A, B and C ride round a circular track at 8, 9 and 10 miles per hour respectively. They start together from the same point, but C rides in an opposite direction to A and B, and meets A one minute after passing B. What is the length of the track?

7. If the manufacturer of a machine sells 36 machines to a wholesale dealer at 25% above cost price, and gives one extra machine free, and if the wholesale dealer sells each machine to a shopkeeper at 5% more than what it cost him, taking into account the machine given free, and if the shopkeeper sells it to a customer for £ 34—13—0 making a profit of 10%, what did it cost to make?

8. A rectangular metal plate has a circular hole in it. The length of the plate is 1·3 meters, the width is 80 cm. and the thickness is 2 m.m. If the plate weighs 32·25 lbs., find the diameter of the hole correct to a centimetre, given 1 c.m. of the metal weighs 8 grams and 1 lb. = 453·6 grams.

9. The following table shows the number of grams of alum which can be dissolved in 100 grams of water at different temperatures :—

Temperature in degrees C.	0°	10°	20°	30°	40°	50°	60°	70°
Grams soluble in 100 Grams of water.	3·9	9·5	15·1	22·0	30·9	44·1	60·6	90·7

Draw a graph and find at what temperature 50 grams of alum could be dissolved in 100 grams of water.

10. A straight rod AB, 2 ft. 8 in. long, is held under water, A being 2 ft. 6 in. and B 1 ft. 2 in. below the surface. Find, by drawing to scale, the distance below the surface of a point C on the rod which divides AB so that AC = $\frac{3}{5}$ BC. Find also the angle which the rod makes with the surface of the water.

11, The cost of making a certain machine consists of an initial expense plus a fixed sum for each machine. To make 25 machines costs £ 885; to make 40 machines costs £ 1,335. Find the initial expense and the fixed sum.

12. ABCD is a quadrilateral field in which the diagonals AC and BD are at right angles. AB, BC, CD, and AC are 600, 700, 800 and 1,000 links respectively. Draw the quadrilateral to scale and hence find the area of the field in acres. (100 links = 22 yards.)

13. A vessel in the form of a hollow right circular cone, whose height is 1 ft. 6 in. and radius of the base 6 in., is placed with its axis vertical and vertex downwards. Find how many gallons of water it will hold (1 cub. ft. = 6·24 gallons). Find also the cost of tinning the inner surface of the vessel at 4 annas per sq. ft.

1926

A

1. The following table shows the values in lakhs of rupees of exports of merchandise from the Madrs Presidency to some of the foreign countries during the years 1920-21, 1921-22 and 1922-23 :—

	1920-21.	1921-22.	1922-23.
	Lakhs.	Lakhs.	Lakhs.
(1) United Kingdom ...	839·77	613·96	824.11
(2) Other countries in British Empire ...	667·37	757·54	743·34
(3) France ...	151·06	426·14	519·67
(4) United States ...	92·59	105·14	150·08
(5) Belgium ...	137·97	108·08	121·24
(6) Germany ...	36·55	93·82	118·36

Find—

(1) the total value of exports from Madras to all the countries during all the three years taken together ;

(2) the percentage of increase or decrease between 1920-21 and 1922-23 in the case of each of the countries (1), (5) and (6).

2. A person going from one place to another travels 90 miles by Steamer, 330 miles by rail and 30 miles by horse. If the journey occupies 30 hours 50 minutes and the rate of the train is three times that of the horse and one and a half times that of the steamer, find the rate of the train.

3. The external length, breadth and depth of a rectangular closed metal vessel are 14, 10 and 9 inches respectively, and the thickness of the metal half an inch. When the vessel is empty, it weighs 1,500 ounces and when filled with water 2,041·6 ounces. Find the weight of a cubic foot a water.

4. Each railway passenger is allowed to take a certain weight of luggage free, and is charged for excess over that weight. Three passengers had to pay Rs. $1\frac{1}{2}$, Rs. 3 and Rs. 4 respectively for 70 lbs., 100 lbs. and 120 lbs. Find graphically (*a*) what a passenger should pay for 145 lbs., (*b*) how much can be taken for Rs. 6, and (*c*) what amount of luggage is allowed free for each passenger.

5. ABCD is a quadrilateral field such that AB = 520 links, BC = 390 links, CD = 250 links, DA = 600 links, and the angle ABC = 90.° Draw the quardilateral to scale, and state what the distance AC is and what the angle CDA is.

Find also the area of the field in acres corret to the second decimal place.

6. A rectangular sheet of drawing paper measures 15 cm. by 25 cm. It is rolled into a cylinder 15 cm. high, the two edges which meet being stuck together by stamp paper. How many c. cm. of sand will the cylinder hold, if it stood upright on a table ?

B

1. A and B became partners in a business and supplied £ 15 000 and £ 4,000 capital respectively. There was a profit, during the year, of £ 1,975 of which B as manager received 30 per cent. and A and B received the same greatest possible integral rate per cent on their capitals which could be paid by the remainder of the profit. How much did each receive and what sum was left over ?

2. When exchange was at 1s. 8d. per rupee, a Madras merchant imported cloth for £ 500 at 6s. 8d. per yard. The cost of importation was 5 d. per yard and the cost of landing and other charges 4 as. per yard. One-fourth of the cloth being damaged, was sold at a loss of 25 per cent on its total cost to the merchant. At what price per yard did he sell the remainder, if he gained 20 per cent. on the total outlay ?

3. A man had two creditors, his debt to the one being double his debt to the other. After paying his larger creditor 4 s. in the £ and the other creditor in full, he had £ 10 left. If he had divided all his estate fairly between them, each would have got 10 s. in the £. What was the value of the estate and how much did he owe each of his creditors ?

4. A bath can be filled by the cold water pipe in 9 minutes and by the hot water pipe in $11\frac{1}{4}$ minutes. A person leaves the bath room after turning on both pipes simultaneously and returns at the moment when the bath should be full. Finding, however, that the waste pipe has been open, he now closes it. In $3\frac{3}{4}$ minutes after this, the bath is full. In what time would the waste-pipe empty it ?

5. At a certain election the number of votes received by A was to that received by B as 19 : 16. At a subsequent

contest between the same candidates, the entire number of votes polled increased by 450 and the excess of A's votes over B's was 270 more than in the former contest. If, at the second election, the number of votes received by A was $\frac{14}{11}$ of that received by B, find the number of votes received by each candidate at each election.

6. A man buys a house on condition that he should pay £ 625 now, £ 625 at the end of the first year and £ 625 at the end of the second year. Calculating compound interest at $5\frac{1}{2}$ per cent. per annum what value to the nearest shilling has been put on the house ?

1927

A

1. The population of a city is 155,625. There are 1,075 females to every 1,000 males. Among the males 12 per cent. are literate and among the females 4 per cent. are literate. Find what per cent. of the total population are literates.

2. At the last Secondary School-Leaving Certificate Public Examination 'a' candidates answered the English papers and the average per cent. of marks that they obtained in that subject was 'x'. Of these 'b' candidates were from the Andhra University area and the average that they obtained in that subject was 'y' per cent. Find z, the average per cent. obtained by the others.

If $a = 15{,}345$, $b = 7{,}375$, $x = 34$ and $y = 35$, find z.

3. If the difference between the simple and compound interest on a certain sum for 3 years at 5 per cent. is Rs. 7-10-0, find the sum.

4. In a club there are 200 members who pay a total annual subscription of Rs. 4,400. Of these some are active members who pay an annual subscription of Rs. 25 each, and the others are associate members who pay an annual subscription of Rs. 15 each. Find how many members there are in each class.

5. A left Madras at 4 A.M. on a certain day and began walking westwards at 3 miles an hour. B left the same place

at 6 A.M. on the same day cycling in the same direction at 6 miles an hour. Find graphically when and where B will overtake A.

6. Construct a quadrilateral ABCD of which two sides AB and BC, 1·1 and 2·4 inches long respectively, contain an angle of 130°, and the other two sides CD and AD are of lengths 2·5 and 3 in. respectively. Find the area of the figure.

B

7. A and B can do a piece of work in 15 days, while B and C do the same work in 18 days and C and A in 20 days. They are paid according to the amount of work that each of them turns out in a day. If C's daily wages are 14 annas, find how much A and how much B receives in a day.

8. A merchant mixes two kinds of coffee, which cost him Rs. 2 a viss and Rs. 2—12—0 a viss respectively, and sells the mixture at Rs. 3 a viss, thereby gaining 20 per cent. on his outlay. Find the proportion in which the two kinds have been mixed.

9. A field 4 acres in area has to be irrigated to a uniform depth of an inch. An 8-inch diameter pipe running full with a velocity of $2\frac{1}{2}$ feet per second carries water to the field from a channel. How long will it take to irrigate the field ?

10. A man performs his journey partly by rail and partly by river, the former at 3 pies per mile and the latter at 6 pies per mile ; the fare amounts to Rs. 3—12—0. But if the rate of the former be reduced by $\frac{1}{2}$ pie per mile and the latter increased by one pie per mile, the fare is increased by 5 annas. Find the distances travelled by rail and river respectively.

11. A man has two plots of ground, one a square whose side is 3,564 yards long, and the other a rectangle 1,628 yards long and 891 yards broad. He exchanges them for a single square plot of the same area. Find the length of a side of the new plot and the cost of fencing it all round at 2 annas per yard.

12. A man 6 feet high standing due east of a street electric light and at a distance of 54 feet from it observes that his shadow is 18 feet long. Find from a plan drawn to scale the height of the light from the ground and verify your result by calculation. How much further east must he go so that his shadow may be 24 feet long?

1928

A

1. Boys and girls of school-going age form 28 per cent of the population of a taluk which is 3,55,000. There are 72 girls of the school-going age for every 68 boys of that age. Of the boys 55 per cent. and of the girls 35 per cent. are at school. Find what per cent. of the total population are at school.

2. A hostel consists of two blocks of buildings. There are a rooms in the western block of which two rooms are used as kitchen and dining rooms, the other rooms being occupied by b students. In the eastern block there are c rooms of which one room is used as a general reading room, the other rooms being occupied by d students. Each room in the western block is let at Rs. 3 and each room in the eastern block at Rs. 4. If Rs. e is the average rent paid by a student in the hostel, connect a, b, c and d with e by an equation. From the equation find the value of e, if $a = 15$, $b=18$, $c=16$ and $d=15$.

3. What sum lent out at compound interest for 3 years at 5 per cent. will amount to Rs. 1,736-7-0?

4. A man performs a journey of 212 miles partly by river and partly by rail, the former at 2 annas 6 pies per mile and the latter at 1 anna 2 pies per mile. The total fare amounted to Rs. 21-2-0. Find the distance travelled by river.

5. On a base of 1,5 inches describe a regular hexagon and determine its area.

B

6. A certain piece of work can be done by 40 men in 60 days. Find the difference in cost if 10 men and 30 boys were

employed instead of 40 men, if 3 boys can do as much as 2 men, and the wages of a man is 10 annas, and of a boy 5 annas, a day.

7. The length of a rectangular field is three times its breadth. The area of the field is 36·3 acres. Find the cost of fencing it all round at 2 annas a yard.

8. A merchant bought in Tinnevelly 160 bags of rice at Rs. 10 a bag of 140 lbs. and sent them by rail to Chidambaram, a distance of 320 miles at 6 pies per mile per ton. During the transit 8 lbs. of rice were stolen from each bag. He sold the remainder at 3 measures per rupee. Find his profit per cent. (1 measure = $3\frac{1}{7}$ lb.)

9. There is a huge cylindrical reservoir where water is stored for 7,700 persons for 3 days at 6 gallons per head per day. Find the height of water in the reservoir if its diameter is 42 feet. 1 cubic foot of water = $6\frac{1}{4}$ gallons.

10. A cyclist left A at 4 A.M. and rode towards B, a distance of 36 miles at the rate of 8 miles an hour. After riding for 2 hours he spent half an hour to do certain repairs and afterwards was able to ride at 5 miles an hour. Find graphically when he would reach B. Just as he reached B, his friend who had left A for the same place and was riding uniformly at 9 miles an hour also reached the place. Find graphically when the latter left A.

1929

1. (i) Given that a metre is 39·37079 inches, find to the nearest yard the difference between 5 miles and 8 kilometres.

(ii) A Bombay merchant owes Rs. 1,410 to a merchant in Berlin and remits it to him through London. If the exchange between Bombay and London is 1*s.* 5*d.* for a rupee and that between London and Berlin is 1 mark for $11\frac{3}{4}d.$, what does the German merchant receive?

2. (i) Use the formula $(a + b)(a - b) = a^2 - b^2$ to simplify $816 \times 784 - 576 \times 624$.

(ii) A dealer buys x viss of ghee at m rupees per viss, and mixes with it y viss of cocogem which he buys at n rupees per viss. He sells the mixture at p rupees per viss. If, in selling the mixture, he uses a false balance by which a substance appears to weigh $1\frac{1}{7}$ times its actual weight, find what profit he makes. If $x=2$, $m=3\frac{1}{8}$, $y=5$, $n=1\frac{3}{4}$ and $p=3$, calculate the profit.

3. In 11 days 250 men working 9 hours a day construct 528 yards of a road which is to be $1\frac{1}{2}$ miles long. How many additional men must be employed in order that, if all now work 10 hours a day, the road may be finished in 33 days more?

4. A man pays $5\frac{1}{2}\%$ of his gross income as life-insurance premium, and on the remainder he pays income-tax at 5 pies in the rupee. If his net income is Rs. 4,233-12-9, find his gross income.

5. Construct a quadrilateral $ABCD$, in which $AB=3{\cdot}7$ in., $BC=3{\cdot}2$ in., $DA=1{\cdot}3$ in., $BD=4$ in., and the angle $BCD=90^\circ$. Find its area.

6. A certain sum of money lent at compound interest amount to Rs. 275-10-0 in two years, and to Rs. 289-6-6 in three years. Find the rate of interest, and the sum lent.

7. A square plot of ground occupying 6·4 acres is bordered on the outside by a path which is $2\frac{1}{2}$ yards wide. Find the cost of gravelling the path at 8 annas per square yard.

8. A man sells two horses for Rs. 440 each. He gains 10% on one horse and loses 10% on the other. What is his gain or loss per cent. on the whole?

9. A tent is in the form of a right circular cylinder surmounted by a cone. The diameter of the cylindrical portion is 24 ft. The height from the ground to the vertex of the cone is 16 ft. while the height of the cylindrical part is 11 ft. Find the cost of the canvas required for the tent at 12 annas per sq. yd. [Take $\pi=3\frac{1}{7}$.]

10. A ladder $32\frac{1}{2}$ ft. long leans against a vertical wall, and the foot of the ladder is 8 ft. from the wall. How far from the ground is a man two-thirds of the way up the ladder?

11. P and Q are two towns 60 miles apart. A rides from P to Q starting at 1 p.m.; B leaves Q at 1-36 p.m. and rides towards P. If they meet at 4 p.m. and A reaches Q at 6 p.m., find *graphically* (i) when B arrives at P, (ii) when A and B are 22 miles apart, (iii) where B is when A is half-way between P and Q.

12. A train travelling at the rate of 50 miles an hour passes a cyclist going in the same direction on a road parallel to the railway in 6 seconds. If the cyclist had been going in the opposite direction, the train would have passed him in 4 seconds. Find the length of the train.

1930

1. The population of the upper part of a town was 20,160 and of the lower part 13,430. A year later the former decreased by 15% but the population of the whole town increased by 1%. What was the percentage increase in the population of the lower part of the town?

2. A can do a piece of work in 60 days and B can do the same in 40 days. After A has worked alone for 26 days, B helps him for 4 more days and then C joins them and the work is finished 6 days later. How long would C alone take to do the whole work?

3. A path d feet wide surrounds a lawn l yds. long and b yds. broad; the total area of the path is A sq. ft. Form an equation connecting A, d, l and b.

If $d=6$, $l=20$ and $A=1404$, find b.

4. By selling motor cycles at Rs. 735 each, a motor dealer was making a profit of $22\frac{1}{2}\%$. Owing to a fall in prices the cost price of a motor cycle is now Rs. 40 less than before and the dealer reduces the sale price by Rs. 40. What is his profit per cent. now?

5. The S. I. at $5\frac{1}{2}\%$ on a certain sum of money for 2 years exceeds the C. I. at 5% on the same sum for the same time by Rs. 2-7-0. Find the sum.

6. Construct a quadrilateral ABCD given that AB = 1·1 in.; BC = 1·3 in.; CD = 1·4 in.; DA = 2 in.; and AC = 1·8 in.

Draw perpendiculars from B and D on AC and measure them. Find the area of the quadrilateral.

7. A right circular cone, made of iron weighs 62·8 tons and its height is 12 ft. Assuming that 1 cubic ft. of iron weighs 448 lbs., find the radius of its base.

8. At a theatre there were 2 classes of tickets costing Rs. 3-8-0 each and Rs. 1-4-0 each respectively. If 340 tickets were sold altogether and the total receipts were Rs. 672-8-0, how many tickets of each class were sold ?

9. The shorter arm of a pair of compasses is 3·8 in. long and the length of the longer arm measured up to the point of the pencil is $4\frac{1}{2}$ in. A circle is described with the compasses keeping the shorter arm perpendicular to the plane of the paper. Find correct to 2 places of decimals, the area and the circumference of the circle ($\pi = \frac{22}{7}$).

10. A car starts for a station 12 miles off at 8 a.m.; 5 minutes later, it overtakes a cart, which is going to the station at 6 miles per hour. The car reaches the station at 8-40 a.m. and after waiting there for 10 minutes returns at the same rate as before. Find graphically when and how far from the station, the car will meet the cart again.

1931

1. 5% of the candidates who appeared for an examination are girls and the rest are boys. 24% of the boys and 36% of the girls fail. If the total number of candidates who pass is 13,195, how many appeared for the examination?

2 A tap fills a bath tub in a minutes and the waste-pipe can empty it in b minutes. When the waste-pipe is open, the tap takes c minutes to fill the tub. Form an equation connecting a, b and c.

If $a=10$, $b=12$, find c.

3. Draw a regular hexagon whose side is 1·4 in. Find its area.

4. A man insured his life for Rs. 1,000 at an annual premium of Rs. 32. If he died immediately after making the

third annual payment, how much does the insurance company lose by the transaction, if money is worth $5\frac{1}{2}\%$ per annum compound interest ?

5. A Madras tradesman buys a motor-car for £ 142 when the exchange value of the rupee is 1*s* $5\frac{3}{4}d$. Freight and other charges on it amount to Rs. 360. What price must be put on the car in order that, after allowing a discount of 10%, he may still make a profit of 20% on his outlay ?

6. *A*, *B* and *C* invest Rs. 2,500, Rs. 1,800 and Rs. 2,000 respectively in a business. After 4 months, *A* withdraws Rs. 700 ; B puts in Rs. 400 ; and *C* puts in Rs. 300. If the profit at the end of the year is Rs. 945, how should it be divided ?

7. Ten cigarette tins are packed into, and just fit, a rectangular card-board box. Each tin is cylindrical in shape, the diameter being 6·7 cm. and the height 7·7 cm. The tins are arranged in two rows of five each, with the circular ends horizontal. Find to the nearest cubic centimetre the vacant space in the box.

8. A contractor employs 78 men and 25 women, and pays them daily wages amounting to Rs. 116—4—0. If 5 men together receive one rupee more than 7 women, what are the daily wages of each man and woman ?

9. A train leaves a station *A* for a station B, distant 50 miles, and travels at 15 miles an hour. An hour later another train leaves B for *A* and travels at the rate of 40 miles an hour. Find *graphically* when and at what distance from *A* the two trains meet. Also find where the first train will be when the second is 2 miles from *A*.

10. (i) *A*, *B*. *C*, *D* are the bottom corners taken in order of a rectangular box, and *A′*, *B′*, *C′*, *D′*, the corresponding top corners. $AB = 12$ in. and $BC = 4$ in. The height of the box is 3 in. Find the distance between (1) A' and C, (2) A and C'.

(ii) A man 5 ft. 6 in. high stands 10 ft. away from a lamp-post and his shadow is 11 ft. in length. Find by drawing a diagram to scale, the height of the light above the ground.

1932

1. One cask contains 50 gallons of wine and another 20 gals. of water. On three successive occasions I draw at the same time 10 gals. from each of them and place them in the other. Express in gals. and decimals of gals. the quantity of wine at the end in each cask.

2. A rectangular estate of 267 acres 3720 sq. yds. was bought by a Mirasdar, its length being $2\frac{1}{2}$ times its breadth. Calculate the cost of fencing it at $2\frac{1}{2}$ as. per yard.

3. If 3 men and 2 boys can do in 6 days what 5 men and 7 boys could do in 3 days, in how much time could 2 men and 5 boys do the same work?

4. The price of a jewel, passing through three hands rises on the whole to 65%. If the first and second sellers secured 20% and 25% profit respectively, what profit did the third make?

5. A man rows a miles down a river and then rows back to his starting-point. If his speed against the current is b miles per hour and his speed in still water is c miles per hour, find his average speed for the double journey. If $b=6$ and $c=16$, what is his average speed?

6. A, B and C are partners in a bank in which they invest £ 12,000, £ 8,000, and £ 5,000 respectively. C is to have 15% of the profits for managing the business; A and B are each to have 2 guineas a day allowed for attendance. A attends 6 days and B, 4 days. If the profit amounts to £ 7,650, how should it be divided?

7. A man bought a house and a garden and sold the former at a profit of 12% and the latter at a loss of 16% thereby gaining Rs. 380 on the whole. Had he sold the house at a gain of 14% and the garden at a loss of 20%, his profit would have been Rs 30 more. What did the house and the garden cost separately?

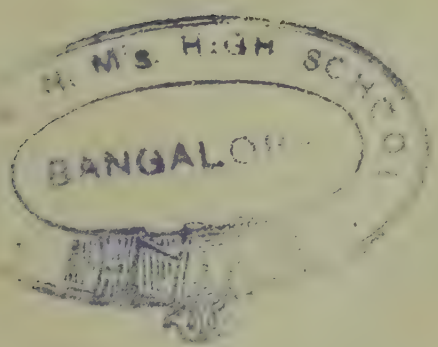
8. Find to the nearest rupee the sum on which the difference between the simple and compound interest for two years at 4% comes to Rs. 8-5-2.

9. Construct, (according to a suitable scale,) the plan of a quadrilateral field $ABCD$, in which $AB=900$ links, $BC=2{,}400$ links, $CD=2{,}100$ links, and $DA=1{,}800$ links, and in which AB is parallel to CD. Find its area by any method.

10. An open box made of wood 1 in. thick is externally 28 in. long, 25 in. broad and 15 in. high, and weighs 50 lbs. Find the weight of a closed box of the same wood and of the same internal dimensions, the planks used being $\frac{1}{2}$ in. thick.

11. B can beat C by 30 yds. in 150 yds. and C can beat A by 10 yds. in 60 yds. Supposing their rates of running to be uniform, find by means of a graph how much start B can give A in 100 yds. so as to run a dead heat with him. If A, B and C start together, where are A and C when B has run 80 yds.?

END



ANSWERS

Exercise I

1. There are 75 fourteen annas $+\frac{154}{14}$ fourteen annas $= 86$ of each Ans.
2. Reduction = savings; $854+216=1070$ Ans.; $3000-1070=1930$.
3. $x-3$, x and $x+3$; $3x=24$; 21, 24, 27 Ans.
4. Rs. $22-8=90$ four-annas; 90 yds. Ans.
5. Rs. $3=4$s; $\therefore 20$s. = Rs. 15 Ans.
6. 1s. $=\frac{2}{3}$ Re.; $\frac{21}{2}$ s = Rs. 7 Ans.
7. In 14 fur. there are $220\times3=660$ koles; in $3\frac{1}{2}$ fur.; $\frac{1}{4}$ of $660=165$ koles.
8. There are 18″ less Ans.
9. I must have measured 8 times *i.e.* 12 in. less; cost of 1 ft. = 2 as. Ans.
10. (24 km = 15m.) + (2k *i.e.* $\frac{1}{5}$km $=\frac{1}{8}$m); $=15\frac{1}{8}$ m. p. h. Ans.
11. $\frac{7610}{48}$ £ = £158 − 10s. − 10d. Ans. or 4s. $=\frac{1}{5}$ and 2d. $=\frac{1}{24}$ of 4s. and Proceed.
12. $\frac{393{\cdot}7}{17}$ ₰. ℘. = 23·15 or 23·2 ₰. ℘. Ans.
13. $23\times18\times5\times$ litres $=230\times9$ litres $=2070$ litres. Ans.
14. $5\times11\times3\times3\times3$ and $5\times2\times3\times3\times3\times2^3$; H. C. F. $=5\times3^3=135$ Ans.
15. 5|87000
    11|17400
    7|1581—9
    225—6

    $Rr=375$; $\therefore 10$ must be added; 87010 is the number.

16. 7000×50 gr $= 5000$ yds.

$$1 \text{ gr} = \frac{1}{70} \text{ yd.}$$

$$25{\cdot}6 = \frac{2{\cdot}56}{7} \text{ yd.} = {\cdot}3657 \ldots\ldots \text{yd.}$$

17. $11\overline{)70{,}000}$

$17\overline{)6363 - 7}$

$374 - 5$ $\quad$ $Rr = 62$; D 374. Hence 374 is Q.

18. In a second he goes 55 in.

$$\text{or } \frac{55}{12} \text{ ft. } i.e., \frac{55 \times 15}{12 \times 22} = 3\tfrac{1}{8} \ m.p.h.$$

19. $\frac{125780}{13} = 9675\frac{5}{13}$; 9,675 and ·005 Ans.

20. $\frac{126}{18} = 7$; 77 and 49.

21. $\frac{2}{3}(x - 40) = 28$; $x - 40 = 42$; $x = 82$ Ans. for diff $= 42$.

22. @ $6\frac{1}{2}$ as. there are $\frac{39}{2} \times \frac{2}{13} \times 16 = 48$ men and 48 children Ans.

23. Rs. 5 can be paid to 32 people. Rs. 37-4-0 = Rs. 9-4-0 = Rs. 21-4-0. Rs. 20 to 128 people. Rs. $1\frac{1}{4}$ to 8 people; **Total = 136 people.**

24. $\frac{36 \times 58}{2 \times 60} \times 3 \times \frac{15}{22} = \frac{261 \times 3}{22} = \frac{783}{22} = 35\frac{13}{22}$ *m.p.h.* (only one simplification).

25. $\frac{3}{10}$ of $\frac{4}{5} = \frac{12}{50}$; *i.e.*, $\frac{100}{24}$ of E = Rs. 10,000.

26. 120 in. = 10 ft.; 6600 for a furlong. 52800 for a mile.

27. Time is $2\frac{2}{3}$ hrs; $12 - 2\frac{2}{3} = 9\frac{1}{3}$; 9-20 a.m. Ans.

28. L. C. M. 360.

29. Find L. C. M. 306; 306×5 and 306×6, *i.e.* 1530, 1836 are the numbers.

30. 72 or 54.

31. 9 parts = 45 pies; 10 parts = 50 pies or 4 as.-2 ps; 4 as. 7 ps. Ans.

32. $20 \times$ £ 5 − 4 − $2\frac{1}{2}$ gives £ 104 − 4 − 2. Balance = £ 4 − 9 − 2 Ans.

33. First yrs. int. is Rs. $7\frac{1}{2}$. Int. for this is 0−12 as. Hence Rs. 15−12 as.

34. At 12% int.=Rs. 9. @ 15% is Rs. 11-4-as. @ 15% for Rs. 9 is 1·35 and total=21·6 Ans., *i.e.*, £ 21-12s.

35. $x^2=4\times484$; $x=2\times22$ *i.e.*, 44; 220 by 88 yds.; P=616. Ans.

36. $\cdot0025\times400=1$. Side=20″. Ans.

37. 480+30+30+Re. 1-14 as.=Rs. 541-14 as.

38. $15\frac{5}{8}\%=(\frac{1}{8})+(\frac{1}{4}$ of $\frac{1}{8})$; Rs. (160−25)=135; Again Rs. (16-14 as.) + Rs. (4-3-6) (135—Rs. 21-1-6 = Rs. 113-14-6.

39. (1·3+·78) (1·3−·78)=2·08×·52=·13×4×13×·16; other side=1·04.

40. Dl=100 yds. 50 yds. Ans.

41. $\sqrt{32\cdot5\times1\cdot3}=1\cdot3\times5=6\cdot5$ ft.

42. $16\frac{2}{3}\%$ of 36 *i.e.*, $\frac{1}{6}$ of 36=Rs. 6. Ans.; method of reversibility.

43. $88\%=401\text{-}8\text{-}0$ *i.e.*, Rs. $\frac{50\text{-}3}{11}$ as.=(Rs. 4-9 as.)=1%

Rs. 456-4 as. Ans.

44. Rs. $\frac{100-6}{88}$ as. $=1\%=$ Rs. $\frac{9-2}{8}$ as. *i.e.*, Rs. 1-2-3

(Rs. 112-8 as.)+(Rs. 1-9 as.) *i.e.* (Rs. 114-1 a.) Ans.

45. 11 parts.=Rs. 220-12 as; 1 pt.=18-4. and 10 parts= Rs. 182-8 as. Ans.

46. $55\times75\times\cdot0001=198$ ∴ $5\times25\times\cdot0001=6$ *i e.*, ·0125= 6; 480 boys and girls. 120 and 360; 54 girls.

47. 110 and 100.

48. 50 inches. Expansion=0·025 for 50.

49. Increase for $2\frac{1}{2}$ is 3 *i.e.* increase of 120%.

50. $1\frac{2}{3}\frac{3}{2}\%$ increase.

51. $16\frac{2}{3}\%=\frac{1}{6}$; 40,000 letters and 120,000 persons.

52. 90·4 % **53.** 607. **54.** 4·05.

55. √4must be √5 in the *Qn.* Rt. ∠d.△

56. 15. **57.** 13 times and 433.

58. 364. **59.** 57. **60.** 3.

61. $\frac{x}{8}=366$; 2928. no. for $\frac{2920}{8}=365$ and 290 must be a leap year.

62. $3 \times 40 = 120$ Ans. for $25+15=40$; there are 3 sets. average $= 20$.

63. 7.

EXERCISE II-A

1. (i) 17
(ii) 9
(iii) 18
(iv) 52
(v) 56
(vi) 1
(vii) 3
(viii) -40
(ix) 1
(x) 20
(xi) 18
(xii) 13
(xiii) 13
(xiv) 3
(xv) 16
(xvi) 24
(xvii) 49
(xviii) 28
(xix) 0
(xx) 27

2. (i) 3
(ii) 11
(iii) 0
(iv) 6
(v) 3
(vi) 24
(vii) 24
(viii) -1
(ix) 3
(x) 30·9
(xi) $-1\frac{1}{2}$
(xii) 0
(xiii) 18
(xiv) 9
(xv) 3·15

3. (i) 37
(ii) 74
(iii) 129
(iv) 48
(v) 65
(vi) 338
(vii) 74
(viii) 65
(ix) 89
(x) 58

4. (i) 1392
(ii) 920
(iii) 1056
(iv) 288
(v) 3024
(vi) 2304
(vii) 2304

5. (i) 448
(ii) 346·5
(iii) 420
(iv) 792
(v) 225
(vi) 108
(vii) 405
(viii) $393\frac{3}{4}$
(ix) 150
(x) 380·3625

EXERCISE II-B

1. 7	**2.** 3	**3.** 1	**4.** 9	**5.** 8.
6. 20	**7.** 3 6	**8.** 5	**9.** 21	**10.** 25.
11. 3	**12.** 2	**13.** 44	**14.** 78	**15.** 70.
16. 15	**17.** 8	**18.** -3	**19.** 32	**20.** 16.
21. 48	**22.** 54	**23.** 80	**24.** 49	

EXERCISE II-C

25. $11x$ **26.** $14a$ **27.** $5m$ **28.** $2a$ **29.** 0 **30.** $4ab$
31. 0 **32.** $-10pq$ **33.** $2x$ **34.** $7x$ **35.** $13x+9y$

36. $-4x-y$ **37.** $10a-3b+4c$ **38.** $m+2n+3p$
39. $5x-2y+3z$ **40.** $p+q+r$.

Exercise II-D

(i) $8a^2-11\,ab+2b^2$ (ii) $4m^2-2m$
(iiii) $x^2+y^2+z^2+xy$ (iv) $2a^2-3ab-3bc+ac$
(v) $7m^2+8n^2+2mn$ (vi) $6x^2+4xy+4y^2$
(vii) $4x^3-4x^2+3x$ (viii) p^2-q^2
(ix) $-q^2+3r^2-pq-pr-qr$
(x) $5\pi r^2+7\pi r$ (xi) $4l^2+2\,lm+m^2$
(xii) $a^3+b^3+3c^3$ (xiii) $2\,(a^2+b^2+c^2)-3ab-ac-bc$
(xiv) $2x^3-x^2y-y^2z-z^2y$ (xv) $10a^3+a^2-a+11$
(xvi) $x^3+y^3+z^3-3\,xyz$

Exercise II-E

1. (i) $2a$ (ii) $8a$ (iii) $9p$
(iv) $6a^2$ (v) a^2+4b^2 (vi) $2a^2+4ab+b^2$
(vii) m^2+mn+n^2 (viii) $2x^2+3xy+4y^2$
(ix) $6xy$ (x) $2a^2+7ab-2b^2$ (xi) p^2+p-1
(xii) $-2b+2c$ (xiii) $a+3b-c$
(xiv) $2a^2-8ab-10b^2$ (xv) $-l^2-4lm+2m^2$
(xvi) a^3+a^2-a (xvii) $-4pq$
(xviii) $a^3+3a^2-5a+11$ (xix) $3a^3+a^2+5a+1$
(xx) $2xy+2xz+2yz$ **2.** $x^2+2xy+y^2+x+y+9$
3. a^2+ab+b^2

Exercise II-F

(i) $5a+b$ (ii) $6a-b$ (iii) 5 (iv) $2a$
(v) $2b$ (vi) $3b$ (vii) $4a-3b$
(viii) $5p-2q$ (ix) 2 (x) $m+n$ (xi) $6m+n$
(xii) $5y-2x$ (xiii) $7x-5y$ (xiv) $-2p-3q$
(xv) $3m+3n$ (xvi) $3b-5c$ (xvii) $7x-2z$
(xviii) $3l+4m-2n$

Exercise II-G

(i) $4a+b$ (ii) $2a+3b$ (iii) $3a-b$ (iv) $x-y$
(v) $6a$ (vi) -1 (vii) $-5x+2y$

(viii) $2m-8n$ (ix) $3p-2q$ (x) $m-n$
(xi) $4y+3z-3x$ (xii) $2m$.

Exercise III-A

1. (i) $15a$ (ii) $28p$ (iii) $24p+12$
(iv) $12p-6$ (v) $2a+2b$ (vi) $-12a+8b$
(vii) $20a^2$ (viii) $8a^2$ (ix) $8a^2+4a$
(x) $10a^2-4a$ (xi) $7a+7b$ (xii) $3a-3b$
(xiii) $6a^2-4ab$ (xiv) $6ab-4b^2$ (xv) $-9a+6b$
(xvi) $-3a^2+2ab$ (xvii) $-5ab-b^2$ (xviii) $14x^2+2xy$
(xix) x^2-7xy (xx) $x^2-7xy-2x$
(xxi) $14a+21b-28c$ (xxii) $10x+20y-200z$
(xxiii) $3m^2-2mn$ (xxiv) $6m^2-4mn$
(xxv) $8pr+10qr-2r^2$ (xxvi) $6a^2-4ab+10ac$
(xxvii) $3a^2+3ab-3ac$ (xxviii) $-14ab+10b^2-2bc$
(xxix) $14a^2+2ab+2b^2$ (xxx) $14a^3+4a^2b-6ab^2$

Exercise III-B

(i) $3x^2+2xy+21x+14y$ (ii) $3x^2-2xy+21x-14y$
(iii) $3x^2-2xy-12x+8y$ (iv) $6x^2-14xy-9x+21y$
(v) $91x^2+6x-72$ (vi) $7x^3+8x^2-4x-5$
(vii) $3a^4-8a^3+5a^2-7a+10$
(viii) m^3-3m^2+3m-1 (ix) $8p^3+4p^2-2p-1$
(x) $7k^3-31k^2+14k-8$
(xi) $4x^4-10x^3+5x^2-7x+10$
(xii) $14x^3-3x^2y-4xy^2+y^3$
(xiii) $14a^3-3a^2b-4ab^2+b^3$ (xiv) $9x^2+4y^2+12xy$
(xv) $9x^2+4y^2-12xy$ (xvi) $16a^2+49b^2-56ab$
(xvii) $16a^2+49b^2+56ab$ (xviii) $144x^4+9y^4-72x^2y^2$
(xix) $144x^4+9y^4+72x^2y^2$
(xx) $m^3+m^2n+m^2+m+mn+1$
(xxi) $m^3-m^2n+m+m^2-mn+1$ (xxii) a^3+b^3
(xxiii) $x^3-3x^2y+3xy^2-y^3$
(xxiv) $a^3-b^3-a^2b-ab^2+ac^2-bc^2$
(xxv) $p^2q+pq^2+q^2r+qr^2+r^2s+2pqr+prs+qrs$
(xxvi) $7x^4+10x^3-5x^2-4x+1$
(xxvii) $4x^5+3x^4-2x^3+3x^2-4x+1$
(xxviii) $7x^5-38x^4+17x^3-9x^2-6x+5$

(xxix) $4m^3+n^3+p^3+4m^2n-4m^2p+mn^2-mp^2-np^2-n^2p$
(xxx) $a^3+b^3+c^3+3abc+2a^2b+2ab^2+2a^2c+2ac^2$

Exercise III-C

1. (i) 2 (ii) 0 (iii) 2 (iv) 441 (v) 5
(vi) 36 (vii) 25 (viii) 529 (ix 63 (x) 42
(xi) 252 (xii) $-\frac{3}{4}$ **2.** (i) $3a^2+ab+2b^2$
(ii) $2x^2+6y^2$ (iii) $4a^2+2ab$ (iv) $3m^2+2n^2$
(v) $-p^3+q^3+p^2+q^2+pq$ (vi) $4ab+3bc$
(vii) $\frac{83a+38b}{12}$ (viii) $\frac{199x}{60}$ (ix) $\frac{20b-a}{40}$

3. (i) $3p^2-13pq+3q^2-3p+8q-19$
(ii) $a^3+b^3-c^3+8$ (iii) $a^2+7b^2+c^2-2ab-ac+3bc$
(iv) $-5x-8y+16z$ (v) $-\frac{a}{4}-b+\frac{5c}{6}$
(vi) $-\frac{a^2}{9}+\frac{b^2}{8}-\frac{3c^2}{5}$ (vii) $\frac{131x-1166}{60}$

4. (i) $a^3+b^3+c^3-3abc$
(ii) $a^2b+a^2c+b^2c+b^2a+c^2a+c^2b+2abc$
(iii) $ab^2-a^2b+a^2c-ac^2+bc^2-b^2c$
(iv) $xy^2-x^2y+yz^2-y^2z+zx^2-z^2x$
(v) $2(a^2b^2+b^2c^2+c^2a^2)-a^4-b^4-c^4$
(vi) $x^4+y^4-z^4+2x^2y^2$ **5.** (i) -9 (ii) 1
(iii) -4 (iv) -53

Exercise III-D

As the questions are quite simple and are for oral work in the class, the answers can be verified easily by the masters.

Exercise IV-A

1. (i) 3 (ii) 1 (iii) 1 (iv) 3
(v) 7 (vi) -11 (vii) 3 (viii) 1
(ix) 1 (x) 3 (xi) 7 (xii) -11
2. (i) 3 (ii) $-2\frac{1}{2}$ (iii) 7 (iv) -2
(v) $3\frac{1}{2}$ (vi) 2 (vii) 4 (viii) 6
(ix) $1\frac{1}{2}$ (x) 4 (xi) Any number
(xii) 11 (xiii) 1·12 **3.** 3 **4.** Rs. 100
5. Any number. **6.** 7

EXERCISE IV-B

1. 48 boys **2.** Rs. 3,800 **3.** 40 ft.
4. 133° and 47° **5.** 12 m.p.h. **6.** 45 and 18
7. 77 and 55 **8.** 77, 79 and 81 **9.** $7\frac{1}{2}$ miles
10. 36 ; Rs. 13 **11.** 15 miles
12. Rs. 4,000 ; Rs. 800 **13.** 18/37
14. 11/28 **15.** 45 and 15 **16.** 94
17. 225 and 450 **18.** 24, 28 and 36 **19.** Rs. 54 ; $\frac{5}{6}$
20. 195 **21.** 24 miles **22.** 86
23. Rs. 110, 70 **24.** 10 and 40 **25.** 30 and 40
26. $5\frac{5}{7}$ days **27.** 70 **28.** 8 and 18
29. 36 **30.** 72. **31.** Rs. 150.
32. Rs, 2,400

EXERCISE IV-C

1. Rs. 3,900 **2.** 30% **3.** 1150 yds.
4. 12 days **5.** 4, 6, 12 and 16 as.
6. Rs. 130, Rs. 260
7. 4 days ; 56 in. **8.** 375,000
9. 60 chairs and 42 per week **10.** Rs. 960
11. 5 **12.** Yes ; 560 **13.** 3250, 3000
14. $3\frac{1}{2}$ b. g : $4\frac{1}{2}$ d ; 12 as. h. **15.** 880
16. 6 miles. **17.** Take $3x-2y$; 13, 12, 5 ; Rt. $\angle$ d$\triangle$; $6\frac{1}{2}$
18. $3\frac{3}{4}$ hrs. **19.** $x=-\frac{1}{2}$, $y=2$
20. 7 : 12. Divide 3·8 internally in the ratio 7 : 12 ; 140, 240
21. 28 tons **22.** PD = 150 ; DQ = 247, BQ = 25

EXERCISE V-A

1. (*a*) 200 (*b*) $16a+b$ **2.** 3 **3.** $20\frac{1}{2}a$

4. $ax=24$ **5.** $36a+\frac{a}{4}=36\frac{1}{4}$as.

6. $13a, a=1,1\&3$ **7.** (*a*) $16a+\frac{a}{4}$ or Rs.$\frac{65a}{64}$ (*b*) or $64c=65a$

8. $x=\frac{10p}{11}$ **9.** (*a*) $16a/x$ (*b*) $1\frac{1}{4}$ as.

10. $6\frac{1}{2}a$; 40,80,400 **11.** (i) $3a+3$ (ii) $3b$
(iii) $3c-3$ **12.** (i) $3x+6$ (ii) $3y$
(iii) $3z-6$ **13.** (*a*) $x-a$ (*b*) $x+a$

14. (*a*) $a-3$ (*b*) $\frac{x-3}{x+4}=\frac{1}{2}$ or $\frac{7}{10}$ is the fraction

Exercise V-B

SYMBOLICAL REPRESENTATION

N.B.—Many of the answers may be thrown into more than one form. In such cases the equalities will be verified easily

1. (i) $a-1$ and $a+1$. (ii) 17, 18 and 19.
2. $2n-1$, $2n+3$; 17 and 19.
3. $5(y-x)$; -10. The given values for x and y are such that $x+y=3x-2y$. ∴ CD in the negative direction is -10.

4. 12. **5.** $\frac{a+4b}{5}$; 140. **6.** $\frac{a(n-1)}{440}$; 110 yds.

7. 3; Rs. 70. **8.** $\frac{c(a+150)(b-2)}{ab}$; Rs. 106-14 as.

9. $\frac{14b}{ax}$ feet; 14 in. **10.** $\frac{2000}{x(100+y)}$; 2.

11. $\frac{1200\,xz}{1760\,x-y}$. **12.** A. $\frac{3y+3z-x}{4}$; B. $\frac{x+z-3y}{4}$; 26, 4.

13. $\frac{abc}{a+b}$ miles; 18. **14.** $\frac{xz}{z-x}$ miles.

15 £ $\frac{x}{20}\left\{\frac{1}{y}+\frac{y}{144}\right\}$ **16.** $\frac{xy(a+b)}{ay+bx}$.

17. $\frac{ax-by}{x-y}$; 39. **18.** $\frac{2x+40}{5}$, $\frac{x+20}{5}$, $\frac{2x-60}{5}$.

19. $\frac{84a+7b\,(ph-m)}{192}$; Rs. 7. **20.** $\frac{88m}{n}-\frac{11x}{y}$.

21. $a(x-15z)=b(15z-y)$. **22.** $x+y$ and $x-y$.

23. $a-b$; By $2b(a-b)$. **24.** $x-2a-b$.

25. $\frac{960-w(3n+2m)}{16}$; 63. **26.** $an+bm=ab$.

27. $202s=16a+b$; 214. **28.** £ $\frac{20a+2b}{5}$.

29. $\frac{100(a-b)}{p+q}$; Rs. 75. **30.** $a-\frac{x(b-a)}{3}$; Rs. 450.

31. $2a+18b$; 3052 yds.; 140 yds.

Exercise V-C

1. $\frac{W}{n^2b}\sqrt{a^2+b^2}$ **2.** $\frac{1}{2}\frac{5}{2}\left(\frac{x}{a}+\frac{b}{2y}\right)$; $6\frac{3}{8}$ miles.

3. $S=\frac{3}{3}\frac{1}{2}R\,(1-\cdot01)-12E$. **4.** $A=24x+2y+3z$.

5. $\frac{C-bh}{a-b^2}$; $\frac{ab-c}{a-b}$ **6.** $\frac{25c}{2ad-bc}$; Rs. 8-5-4

7. 51 and 74. **8.** $\frac{ag}{b+g}+12p+m$.

9. $\frac{pq}{qt-p}$ **10.** $\frac{a+b}{2}$ gms.

11. $b=\frac{l-t-2p}{a-b}$; 38. **12.** $\frac{m(a-2)+n(b-1)}{5}=p$; 56.

13. $\frac{s}{60}(T+t)$; $\frac{s}{60}(T-t)$; 45 and 35.

14. $a+b$; $2\frac{l^2+s}{l}$; $\frac{1}{l}\sqrt{l^4+s^2}$

Exercise V-D.

1. $\frac{1}{s}(36x+12y+z-72a)$ **2.** $\frac{1}{x}(12b-av-ct)$

3. (*a*) $\frac{5280}{x-1}$ (*b*) $\frac{3600(n-1)}{m(x-1)}$

4. $x+y=a$; $\frac{ab}{b+1}$, $\frac{a}{b+1}$ **5.** (*a*) $x-a$

(*b*) $y-a$ (*c*) $x-a=2(y-a)$ **6.** $3l-2a$

7 $4a-b$ **8.** (*a*) $\frac{1760c}{2(a+b)}$; (*b*) $\frac{2p(a+b)}{1760}$

(*c*) $\frac{a+b}{220}$, $\frac{220c}{a+b}$, $\frac{p}{4}$ hrs.

9. $\frac{8a-38}{7}$ **10.** $ma-x(m+n)$ annas.

11. (*a*) $2a(x+y)$; 286 in. (*b*) a^2xy; 4991·25 sq. in.
(*c*) $a\sqrt{x^2+y^2}$ 102·3 in.

12. $2v=x-(a+b-c)$; 125

13. $x=\frac{P(a+b)}{a}$; $x=37$, $P=16{\cdot}875$.

14. $x=\frac{pr+t}{q+r}$; 28 **15.** $x=\frac{p+q}{b-a}$; 62

16. $60T=\frac{a}{p}+\frac{b}{q}+\frac{c}{r}$ **17.** $\frac{1}{x}+\frac{1}{y}=\frac{2}{z}$

18. $T=\frac{ax-(x-p)(a-b)}{P}$; 20·9

19. $\frac{1}{4}(x+y)(3a+60)-(ax+16by)$; Rs. 2-4-0

20. $2a-(b+c+d)=x$.

21. $\text{Rs}_{1\,9\,2}^{\frac{1}{2}}$ $(48\,bx+18\,sy+160tz)$ **22.** $m=3n$

23. $P=\frac{1}{4}(x-a-b+2c)$ $Q=\frac{1}{2}(x-a-b)$;
$R=\frac{1}{4}(x-a-b-2c)$.

24. $12a(16-m)+b(12-m)=12x$; 9

25. $\frac{ab(s-p-q)}{ab-bp-aq}$; $6\frac{6}{7}$

Exercise V-E

1. (*a*) 161·875. (*b*) $l=\frac{A}{b}=40$. (*c*) $b=\frac{A}{l}=9$.

2. (*a*) 15. (*b*) 16·48, (*c*) 11, (*d*) 840.

3. $2h(l+b)+2lb$. **4.** $b=8$; $h=5$; $A=28$.

5. $h=\frac{2A}{a+b}$; $a=\frac{2A}{h}-b$; $b=15$.

6. $a=\frac{2\triangle}{b}=5$; $b=\frac{2\triangle}{a}=9$.

7. $r=3$. $S=16\pi$. **8.** $S=\frac{\pi d^2}{4}=4\pi$.

9. $P=\frac{100I}{nr}$; $n=2$; $r=5$; $P=300$.

10. $A=$Rs. 110-4 as. $P=1600$.

11. 239·2 Sq. units; $\frac{a^2}{4}\sqrt{3}$; $4\sqrt{3}$ Sq. in.

12. $V=36\pi$, $r=2$, $h=5$. **13.** $c=20\pi$, $r=3$, $h=6$.

14. $S=15\pi$, $h=2\sqrt{15}$, $h=\sqrt{91}$. **15.** $V=96\pi$; $r=3$, $h=5$

16. $w=\frac{W(S-1)}{5}=32{\cdot}21$.

17. (1) 5904. (2) $\frac{s}{t}-\frac{1}{2}gt^2$. (3) $\frac{2(S-ut)}{t^2}$

18. $c=\frac{5F-160}{9}=30$

Exercise VI

1. 9,21,5,14,11 **2.** Rs. 5-8-0 **3.** 5−8
4. 7as 10 ps. **5.** 40 gr. **6.** $13\frac{1}{2}$ ft.
7. 12·85 **8.** 42 **9.** 17·6
10. $4\frac{1}{30}$ sq. yds. **11.** 72lb. **12.** 6·4
13. $5\frac{9}{16}$ **14.** Rs. 5-10-0 and 5-10-0

15. Rs. 17-14-8 and 17-9-4 **16.** $\frac{12x-10y}{2}$, 28

17. $\frac{7m+8{\cdot}5n}{m+n}$; 7·6 **18.** 52 **19.** 69.

20. 90,87,81 **21.** 38 **22.** Rs. 15

Exercise VII-A

1. $23\frac{1}{3}\%$ **2.** Rs. 75 **3.** $\frac{1}{3}$ or $33\frac{1}{3}\%$
4. 37·1% **5.** 11·1% **6.** $41\frac{2}{3}\%$
7. 45% **8.** Rs. 2,450 **9.** Rs. 612
10. Rs. 1,600 **11.** Rs. 12,500
12. Rs. 500 **13.** 3·1% **14.** 225

15. 30%, $\frac{1}{250}$; 50 % **16.** 8% **17.** Rs. 500
18. £ 479-11-10 **19.** 50,000 **20.** £ 1—5s.
21. $12\frac{1}{2}$s. **22.** 185 for £ 1. **23.** $12\frac{1}{3}$%
24. 1,240 **25.** 5 eggs.

Exercise VII-B

1. 12,480 **2.** 8,00,000
3. By $28\frac{4}{7}$%; 12% **4.** 4 as. **5.** $30\frac{10}{11}$%
6. 15 **7.** $x=60$; Rs. 9 and $10\frac{1}{2}$
8. $31\frac{1}{4}$%; $27\frac{1}{2}$% **9.** Rs. 25; $33\frac{1}{3}$%
10. 20 lbs. **11.** £ 303-15*s* **12.** Rs. 1-9 as.
13. 50%; 1,800 **14.** 1·88% loss **15.** Rs. 21-10 as.
16. $\frac{2}{15}$ of stock **17.** $6\frac{2}{3}$% gain
18. Rs. 20; Rs. $333\frac{1}{3}$ **19.** Rs. 99
20. Trader 11·7% profit; agent 12%
21. Rs 28-12 as.; 19·7% **22.** 17·7% **23.** $16\frac{2}{3}$%
24. 28·8, 14·4, 9·6, 7·2, 24 and 16 **25.** 43,16,000; 14·6
26. 75 and 25 *oz* **27.** 38% of c; 26 of z and 36 of tin.
28. (i) $66\frac{2}{7}$ p.c. (ii) 446.4 tons

Exercise VII-C

1. 30%, 25%, 40% $12\frac{1}{2}$ % **2.** Author, Rs. 5,322 Bookseller Rs. 4,920
3. Rs. 4,800 **4.** 206%; 21·9%
5. 91·5% **6.** Rs. 800 **7.** Rs. 2,400
8. 160 **9.** $9\frac{3}{8}$%, 18·5%
10. $9\frac{11}{2}$% **11.** (i) 6%, (ii) 18%
12. 12 : 5; 960 viss **13.** 28·1% **14.** 29·2%
15. $2ab=7c$; Rs. $1,071\frac{3}{7}$
16. Rs. 1,450, 1,160, Rs. 22-4 as. gain
17. Rs. 64-10 as.; 30·5% **18.** 60%, 40%
19. 30·6% **20.** Cost Rs. 4-12 as., Quoted Price Rs. 5-15 as.
21. 11s-7d. nearly **22.** Quadrupled the capital
23. 57%, Rs. $12\frac{1}{2}$, Rs. $62\frac{1}{2}$ **24.** 37·2%
25. Rs. 620-13-4 **26.** Rs. 16-4-3
27. 93·35% **28.** B $22\frac{1}{2}$, A 27, C 30, A 35, B, $12\frac{1}{2}$, C 50 p.c.

29. Rs. $337\frac{1}{2}$ **30.** Rs. $1\frac{1}{2}$, Rs. $262\frac{1}{2}$
31. $37\frac{11}{2}$ **32.** $y=\frac{4}{3}x$, Rs. 6; Rs. $2\frac{1}{2}$
33. Profits decrease 30 ; 29
34. (i) 2 as. 1 pie; 3 as. 4 ps.; 3 as. 9 ps.; 8 as. 9 ps.;
(ii) 4 as. $9\frac{3}{5}$ ps.; 4 as. $4\frac{4}{5}$ ps.; 2 as. $9\frac{3}{5}$ ps.; 1*a* $7\frac{1}{5}$ ps.

Exercise VIII-A

1. (i) Rs. 91-6-6 (ii) Rs. 140-10-0 (iii) Rs. 504
(iv) Rs. 6 **2.** (i) 750 (ii) 450 (iii) 225
(iv) 40 **3.** (i) $3\frac{3}{4}$ (ii) $7\frac{1}{2}$ (iii) £ 38-10; 8-13-3
4. $6\frac{19}{64}\%$ **5.** Rs. 2880
6. Rs. 3360-11-6. He draws interest and a portion of the principal.
7. (i) $570\frac{5}{16}$ p.c. (ii) 154 days. **8.** Rs. 120 gain
9. Rs. 1590 **10.** Rs. $90{,}933\frac{1}{3}$ **11.** 450, 4%
12. Rs. 2850 **13.** 750 and 1050 **14.** Rs. $1666\frac{2}{3}$
15. $32\frac{8}{11}$ *p.c.* **16.** Rs. 62−3 as. nearly
17. Rs. 8464 **18.** 49*f*−58*c*.
19. $4\frac{4}{19}\%$; £ 4750
20. Waiting by 42-13-4 **21.** Rs. 4,185-4 as.
22. $5\frac{1}{2}\%$ **23.** $4\frac{1}{2}\%$ **24.** 1920

Exercise VIII-B

1. (*a*) Rs. $184\frac{1}{2}$ (*b*) £ 216 6s. (*c*) Rs. 702-12-3
(*d*) Rs. 1,182-15 as. **2.** Rs. 7,500 **3.** Rs. 9-14 as.
4. 4%; £ 250 **5.** £ 1,600 **6.** $3\frac{1}{2}\%$
7. Rs. 7,187-8 as. **8.** 5%; £ 4,000 **9.** Rs. 5,000
10. 680,5% **11.** 2,000 and 4,000
12. Latter Rs. 379-6 as. **13.** 4% **14.** Rs. 441

Exercise IX

1. 24 lights **2.** 20 days **3.** 12 days
4. 14 pints **5.** Just sufficient at full rations
6. 2 days; half and half **7.** 9·6 days **8.** 60 days
9. 21 **10.** 3 coolies
11. Rs. 15-9as. **12.** 5·5 days **13.** 4 days
14. £ 6,000 **15.** $52\frac{1}{2}$ min : 120 min.

16. $19\frac{5}{8}$ days **17.** $16\frac{4}{5}$ days more
18. 7 days **19.** 33·6, 24, $18\frac{2}{3}$ hrs.
20. 3·5 days nearly **21.** 2 men **22.** 3 : 2
23. 22, 7 and 12 gallons.

Exercise X-A

1. $6\frac{3}{4}$yds. **2.** $31\frac{1}{4}$ miles **3.** $35\frac{5}{7}$ cm ; $78\frac{4}{7}$sq. cms.
4. $961\frac{1}{7}$ sq. ft. **5.** $173\frac{1}{4}$ sq. in. **6.** 22·8 in.
7. 1·37 sq. in. **8.** 4·6 sq. cms.
9. 132·7 sq. c. ; The diameter is 13 cms. Rt. $\angle d$. $\triangle$
10. 12·6 cms. ; 55·44 sq. cms. **11.** $\frac{5}{9}$ of original
12. 1 : 0·97 **13.** $\frac{1}{4}$ of O^{ce} ; 33 : 25, Four
14. (i) 32 (ii) 7 (iii) 14
(iv) 18 (v) $68\frac{1}{2}$ nearly (vi) 35
15. 170 sq. cms. **16.** $41\frac{19}{21}$ **17.** 6·3
18. 314 sq. cms **19.** (i) $12\frac{4}{7}$ (ii) $25\frac{1}{7}$; 1 : 2
20. 28 sq. in. **21.** 89 ft ; $414\frac{3}{4}$ sq. ft.
22. $\frac{11}{14}$ ft. **23.** 5040 yds.

Exercise X-B

1. (*a*) 2 cms. (*b*) 1·95 **2.** (*a*) $\sqrt{5}$ in. (*b*) 2·3 in.
(*c*) ·2 in **3.** (*a*) Find $\sqrt{5}-1$ geometrically (*b*) 2·1″
4. 28 : 3 **5.** 6·3 miles **6.** $6\frac{1}{2}$ ft. **7.** (*a*) 1·4 ft.
(*b*) 2·9 cms ; 6·5 cms : 7 cms.
8. (*a*) 9·0 sq. cms ; 305·1 sq. cms. (*b*) 3·14 sq. cms.
9. $\frac{3}{4}$ of O^{ce} of $r=60$ ft. $+\frac{1}{2}$ O^{ce} of $r=20$ ft.
10. ·4 sq. in ; (1) ·6 sq. in. (2) ·8 sq. in. **11.** 4·5 sq. in.
12. 27 miles **13.** 82·1 sq. in. **14.** 192π **15.** 3·8 ft.

16. (*a*) With centre O, draw radii OP, OB making $\angle$ of 60°. Produce OB to D so that OD = 6 cms. DP will be a tangent of $3\sqrt{3}$ in.

(*b*) Area of OPD $=\frac{9}{2}\sqrt{3}$ sq. cms. $\therefore$ area of OPDQ $=9\sqrt{3}$sq. cms. Area of sector POQ $=\frac{1}{3}\times 9\times\frac{22}{7}$sq. cms. ;
17. (*b*) 3 cms., (*c*) 4·3 cms. **18.** See on 'circles'.
19. 33·8 sq. ft. Rs. 25-5-8 **20.** $\sqrt{5}$ in. **21.** 8·54″
22. 3·1 sq. in or ·24 sq. in. **23.** 1 foot.

Exercise XI

1. 121·4 ft. **2.** 13 units. **3.** 8·5 ft.
4. 17 and 15. **5.** 27 ft. **6.** 105 yards.
7. 9 cms. **8.** $3\sqrt{5}$; $6\sqrt{5}$; $225=15^2$. **9.** 68 ft.
10. Rs. 2−15 as. **11.** 12 yds. **12.** 52 ft.

Exercise XII-A

1. 8·75 gr. **2.** 10·4. **3.** $t=a+b$.
4. 43·3 ft $=\sqrt{l^2+b^2+h^2}$; 36 persons. **5.** 6 in.
6. 368 c.ft. nearly. **7.** $7\frac{1}{2}$ in. **8.** 16c.ft. 159 in.
9. 12·14″. **10.** 25·9 c. in. **11.** 1·7″.
12. $141\frac{2}{3}$ lb. **13.** 211 nearly. **14.** $16\frac{1}{2}$.
15. $10\frac{1}{8}$. **16.** $5\frac{5}{8}$ hrs. **17.** 25 sec. nearly.
18. 0·5 c. in nearly. **19.** 8 drums. **20.** 0·5 cm.
21. $125\frac{5}{8}$ c. in. **22.** $9\frac{7}{17}$ ft. **23.** 15 ft.
24. Rs. 234−6 as. **25.** 20 trips to and fro.
26. 407 acres; $15\frac{1}{4}$ sq. miles. **27.** 0·83 c. in.

Exercise XII-B

SOLIDS—PRISMS

1. 4 inches. **2.** 50 tons 17 cwts. 96 lbs.
3. $176785\frac{5}{7}$ **4.** £ 64 **5.** 278″, $69\frac{1}{2}$ depth.
6. 139 days' supply **7.** 2340 lbs.; 8 **8.** 1·53 ft.
9. 40 cms. **10.** 4900 c.c.; 30 kg. 200 gr.
11. 5 cm. **12.** 1·25 lb. nearly. **13.** 4·48 ft.
14. 49 **15.** 0·642 lb. **16.** $92\frac{1}{7}$ c. ft.

Exercise XII-C

1. $\frac{s}{s+s}$ **2.** 5·95″; 367·2 c. in. **3.** $134\frac{3}{8}$ c. ft.
4. $3\frac{5}{9}$″ **5.** 3 hrs. 59 min. 23 secs. **6.** $28\frac{4}{9}$ buckets
7. 1·4 inches **8.** 2·4″. **9.** 6·26 cm.
10. 5·04 ft. **11.** ·069″ **12.** $11\frac{1}{9}\%$

Exercise XIII-A

1. (i) 8 (ii) 35 (iii) 14 (iv) 65
(v) 122 (vi) 60 **2.** 0·7,″ 2·4, 1·232 c. in.

3. 3,300 sq. cms. 4. $\frac{53}{64}$ 5. $10\frac{1}{2}''$ and 14 in.
6. $\frac{21}{22}\sqrt{6}$ 7. $375\frac{3}{8}$ sq. ft. 8. 8·5 in.
9. Rs. 217-2 as.

Exercise XIII-B

CONES.

1. $38\frac{1}{2}$ sq. in.; $9\frac{5}{8}$ sq. in.
2. A sector 14″ radius, length of arc 52·8″; Central $\angle 216^\circ$
3. $2\frac{2}{3}$ cms. 4. 17248 c. ft.
5. $\frac{1}{3}$ of the volume of cylinder = Volume of Cone. The water will fall by $\frac{a}{3}$ inch.
6. $10\frac{1}{8}$ inches 7. $\frac{299}{324}$
8. An isosceles triangle; equal sides 9·1″ and base 7 in. Perimeter = 25·2″ 9. 12 sq. ft. $58\frac{1}{2}$ sq. in.
10. $61\frac{1}{4}$ measures 11. 1·69 in. 12. 12·6 ft.

Exercise XIV-A

3. (ii) 9 hrs.
(iii) 10 miles. $\frac{1}{10}''$ = 1 mile. Measure carefully
4. 9 − 25′ 5. 5 − 48′ a.m.
6. 24 and 10 respectively 7. 750 and 650
8. 16 and 4 respy. 9. 15 miles
10. 10 points 11. 21 miles
12. $1\frac{2}{3}$ miles 13. (i) 3, −2 (ii) −5, 2
(iii) $4\frac{1}{2}, -2\frac{1}{2}$ (iv) 2·3, −1·2 (v) 7, $2\frac{1}{2}$
(vi) $\frac{1}{2}, \frac{1}{3}$ (vii) $-1\frac{1}{2}, -\frac{3}{4}$ (viii) 4, 3
(ix) 12, 5 (x) 3, 4
14. (i) In. 1 hr. 52 min. from start.
(ii) 25 min. and 1 hour 37 mins from start
15. 12. m. p. h. 16. 6 th. mile; 30 miles
17. Total time 5 hrs. 48′; Rate 8 m. p. h.
18. 30 miles per hour 19. (i) $y = a + bx$
(ii) Rs. 10, Rs. 7 (iii) Rs. 73
20. (0, 4) is a point in graph (i) and (3, 0) is a point in graph (ii) join each to 2, −3

Exercise XIV-B

1. 9 days **2.** 1 anna; Re. 1-11 as.
3. £ 11,00000 **4.** (*a*) 6 fur.; 88 yds. per min.
(*b*) 33 miles **5.** (i) Rs. 185; (ii) $x+20y=250$. $x+28y=276$
(iii) Rs. 263 **6.** 6 years; 26 years
7. Rs. 5, annual increment. **8.** Rs. 80, Rs. 4
9. $y=mx+c$., 49, 85; 36, 48 **10.** $24\frac{4}{9}$ or $24\frac{1}{2}$ nearly
11. 90 yards **12.** $21\frac{9}{11}$ min., $5\frac{5}{11}$ min. and $38\frac{2}{11}$ min., $54\frac{6}{11}$ min. past four
13. Free 12 lbs. $\frac{1}{2}$ anna per lb. **14** $x=45$. Rs. 540
15. 3,000 **16.** 30 **17.** (i) 40lbs. (ii) 34 lbs.

Exercise XV

1. (i) $\frac{1}{2}$ min. (ii) $30\frac{3}{4}$ *m. p. h.* (iii) 110 ft. & 30 *m. p. h.*
(iv) 165 ft. $22\frac{1}{2}$ *m. p. h.* (v) 10″ (vi) 33 ft.; $11\frac{1}{4}$ *m. p. h.*
2. $4\frac{7}{8}$ min. **3.** $12\frac{3}{10}$ min. **4.** 5 mins. 23 sec.
5. 30 & 15 *m. p. h.* nearly **6.** $45(l+x)=22mn$; 176 yds.
7. 142 ft. **8.** $54\frac{6}{11}$ min. past four
9. $21\frac{9}{11}$, $54\frac{6}{11}$ min. past 1

MISCELLANEOUS EXAMPLES

1. 10 cwt. 3 qrs. $8\frac{1}{2}$ oz. **2.** Rs. 72,900
3. 6·8 ft. **4.** $\frac{9x}{2}$ *d.* less; does not depend on *a*
5. 24*d* **6.** 8 days **7.** 4 %; £ $322-18-4d$.
8. 10·365 of gold; 24·185 of silver **9.** $2\frac{1}{3}$ ft.
10. 12 seconds **11.** 12,000.
12. 37 min. 20 secs.; $11\frac{2}{3}$, $10\frac{2}{3}$ **13.** $\frac{(b+c)\,xy}{by+cx}$. $Z=3\frac{3}{5}$
14. 404,726 **15.** 4 min. 22 sec.; 4 min. 9 sec.
16. 1·9 cm; 8·5 cm. **17.** 16·4 in.
18. 396; 0·09; ·094. **19.** 68%
20. $5\frac{1}{4}$ miles from Q; 12 miles **21.** 2*s*.

22. 209·5 yds. **23.** 82 sq. in.
24. 25 cm., 1 ft. 2·88 in.; 25 sq. cm.
25. $\frac{5}{9}$ of a gallon **26.** $\frac{360x}{\pi d}$, $\frac{\pi}{360}$; £$\frac{100x}{100+y}$; £ 760
27. 20 miles **28.** 135 yards; 67½ seconds
29. 12,000 gallons **30.** 18·2 ft. **31.** 1·22 *m.p.h.*
32. 104 $\frac{6}{21}$ ft.; 75 ft. **33.** 1·63″ **34.** $8\frac{8}{11}'$
35. 162 sq. ft. **36.** 250 sq. in.
37. Rs. 23 − 10 as.; parallel to shorter side
38. 33 and 21. **39.** 12·2; 4½ mls. from station
40. 45·6 sq. in. **41.** 66 : 35; 1%
42. 2366 ft **43.** Latter 20′ earlier **44.** Rs. 210
45. 7 − 7′ − 30″ **46.** 14/165. **47.** 10 mls, 24 mls.
48. 40′ 99″ **49.** 9600 sq. ft.; 1128000 c. ft.
50. *G.* 76; *S.* 30. **51.** I: III 2, 5; III, II 2, 5
52. 1 in. nearly **53.** $\frac{2ar}{r^2+a^2}$ **54.** Rs. 3750
55. 1½″ **56.** 88 sq. in. **57.** 11,400
58. ·7 in. **59.** $M=\frac{ac}{16}-(b-30)\,a$; $r=5$, $a=10$
60. $a-\frac{2s}{d-s}$ **61.** $10\sqrt{3}$ in.; $192\sqrt{3}$ sq. metres
62. 25; 2433 yds. **63.** 308 ft.
64. $1+\frac{1}{2}\sqrt{6}=2{\cdot}22''$ **65.** $\frac{21cx}{dy}$ **66.** 24·8 sq. yds.
67. Cir: sq: Hex. = 1, 1·3, 1·1 **68.** 28′ 39″
69. 9·3 ps. **70.** $\frac{360\,a^\circ}{a+b}$, $\frac{360\,b^\circ}{a+b}$; Rs. $\frac{100\,x}{100-y}$
71. 3·82 in. **72.** Rs. $\frac{5}{8}$ of 1800 = Rs. 1125.
73. 1190 : 850 **74.** 850 tin and 350 lead
75. 2 : 3 **76.** DP = $\frac{2}{5}$ of a side of the square
77. Re. 1, per day **78.** 64 ft.; 20·6 ft.
79. 25 and 60.

REVISION PAPERS

Paper I

1. 240 measures **2.** Gain Rs. 229
3. Each 3 hrs. 55 min. **4.** 1·8 miles behind

Paper II

1. Rs. 111-7-6 **2.** 3·36 ft.
3. Rs. 2-13 as. a viss **4.** $3r^2 = 4p^2$

Paper III

1. 7·2 cms. The same length, the same distance.
2. Rs. 53-6 as. **3.** 120·5
4. $29\frac{1}{2}$ miles

Paper IV

1. Perimeter = 156·2 yds. Area = 1,362 sq. yds.
2. Rs. 2-4 as. **3.** 21 more men
4. By 0·15 of its volume

Paper V

1. 8 miles; $\frac{ax+by+cz}{x+y+z}$ **2.** $31\frac{1}{4}$ ft. **3.** 40
4. 4-104 sq. in.

Paper VI

1. 6 m. p. h. **2.** $\frac{1}{4}$ length
3. Rs. 240 salary and discount of 4 p. c. on sales
4. Rs. 6-8 as.

Paper VII

1. 4 sq. in. : $\frac{1}{2}$ mile **2.** $11\frac{1}{4}$ p. c.
3. 2 m. 5 fur. 60 yds. **4.** 215 yds. 2 ft. ; 38 ft.

Paper VIII

1. 20 days **2.** 28
3. 88 yds. ; 20 m. p. h. **4.** £ 300

Paper IX

1. Rs. 3-12 as. **2.** 192 **3.** 7 : 5
4. 18, 18½ **5.** £ 2,604⅙

Paper X

1. q^3/p^2. **2.** 880 yds.
3. 3⅓ m. p. h. 977⅞ yds **4.** 6 times ¾ = (10 − 5½); Re. 1-8 as. Rs. 50
5. 120 copies **6.** 1836 c. in. Rs. 5-9-4 pies
7. 1 in 55 nearly

Paper XI

1. 9 hrs. **2.** 183·4 ft.
3. 22⅔ p. c. **4.** $\frac{3}{40}$ s. $\frac{abxyz}{1728}$
5. Rs. 9; 15·4 p. c. nearly **6.** 13 s.
7. Equilateral triangle; $27\sqrt{3}$

Paper XII

1. Nearly 2 miles
2. (30 by 21) + (30 by 21) + two semi-circular ends of radius 21 ft. = 2646 sq. ft.
3. 32 : 1
4. Rs. 3-12-9, Rs. 5-1-0, Rs. 6-12-0, Rs. 9, Rs. 12 respectively
5. 41, 28. **6.** 8 miles, 11-48′ **7.** 515 c. ft

Paper XIII

1. 10·5 **2.** 2·3 sq. in. both equal **3.** 24
4. (i) 15·4 sq. cms. (ii) 421 (iii) $3a = 88bx$
5. Rs. 394-7-3 **6.** £ 410
7. 10-49′-48″, 30 m. p. h.

Paper XIV

1. $\frac{Pabc}{(a+1)(b+1)(c+1)}$; 225 **2.** 10⅝ min.
3. QM = 5 in. **4.** At 1 − 45 p. m.

5. 9 hours 6 minutes nearly
6. House 5500, Plant 12,000.
7. $t=\frac{1}{2}''$; 765 has factors 17, 9 and 5. Corresponding to $18-2t$, $10-2t$ and $6-2t$
8. 2 hours 48 minutes

Paper XV

1. (i) $\frac{100x}{100-a}$ (ii) 17.
2. (i) 90·98 From 100 yds. subtract for $\frac{1}{2}$ yd. (ii) £ 20 (iii) Time 3 : 2; 1−48′.
3. 9 miles per hr. **4.** $1\frac{1}{8}$ pints
5. 11-8 yds. **6.** Rs. 658-12 as. **7.** 10 days
8. 6·9 min. **9.** 7 in. each way; 7776 packets

Paper XVI

1. 5·73 km.; 3·58 miles per hour
2. (i) 37·100 (ii) 33761 quarter-annas, 7974 half-annas and 27165 pies
3. Describe semi-circles on AC and BD. Where they cut is T
4. 1·414 in.; ·024 c. in. **5.** $9\frac{8}{9}$ days
6. $11\frac{1}{9}\%$ **7.** End of 4th year Rs. 6-2-10
8. 213 cwt.

Paper XVII

1. $3x$ pence and $\frac{12}{x}d$, $x=2$. **2.** 57·3 ft. per sec.
3. 1100; 550I, 352S, 198E **4.** $4\frac{1}{2}$. $31\frac{1}{2}$, $22\frac{1}{2}$
5. 2 miles **6.** 4·2 litres; 26 mm.
7. 5 : 8; 32 gallons **8.** $x=66$, $10\frac{1}{2}$ in.

S. S. L. C. PAPERS
1911

3. Rs. 3295-11-0 **4.** 63·7 and 18·8
5. Rs. 90 more than the man who bought the house
6. 878 **7.** 490 yds.

8. The real length is either 40·124 or 40·118 as the line may be measured from either end of the ruler
9. $x=8,\ y-5$
10. No. 1 is 100 miles, No. 2, 305 miles and No. 3. 275 miles from Madras (*b*) No. 1 passes No. 2 at 2-15 A.M. Tuesday, and No. 1 passes No. 3 at 4 A.M. Tuesday
12. Area of $\triangle = 0{\cdot}8$ sq. in. nearly **13.** 27·6″
14. 35 ft. nearly
15. Rs. 165-0-7 to the nearest pie

1912

1. $70, 33\frac{1}{3}, 17\frac{1}{3}, 96\frac{2}{3}, 60, 25\frac{1}{3}, 14, 87\frac{1}{3}, 53, 30, 38\frac{2}{3}, 76$—Percentages respectively; 4, 8, 11, 1, 5, 10, 12, 2, 6, 9, 7, 3—Rank respectively
2. Rs. 80-12 as., Rs. 303-3 as., Rs. 192-11 as., Rs. 202-9 as., Rs. 260-11 as., Rs. 354-3 as., Rs. 51 respectively
3. i. Rs. 274-8 as. nearly
4. 60′ 4·5″; 141·43 correct to 5 significant figures
6. 1571 sq. ft. nearly
8. Midnight on Monday 103·4° nearly and 8−30′ on Tuesday morning 100·35° nearly
9. 4466·2 tolas.
12. ·489x grammes per sq. cm. $=x$ lbs. per sq, ft.
13. Rs. 4 **14.** 45 cms. nearly
15. 8 as. to the nearest pie.

1913

1. (*a*) (1) 919,366; (2) 266,527; 67099; 61571: 40673; 31321; (*b*) 3·24
2. (1) £ 49-6-3, (2) Rs. 336-11-5
3. 3035 ft. **4.** $x=4 : y=3$.
5. $x/36$ furlongs where x is the no. of revolutions of the pedal; 13 fur. 195 yds. 1 ft. 8 in.
6. II : I : : 2 : 1; $H_1 : H_2 : : 4 ; 1$.
7. 2 in. 8. 90°, 53° and 37°; 7·07 sq. in.
10. Rs. 306-4 **11.** Rs. 2-10-7
12. 3,103·788 kg. **13.** 6·9%

1914

1. $+35{\cdot}1\,\% \cdot -7\%$; + 355·5 p.c. +38·7 p.c. +17·3 p.c. 698,667; 683,348; −2·2 p.c.
3. $(mx-ny) \div (m-n)$; 10 nearly
4. $W : M :: 5 : 16$. **5.** $1000r \div (100+p) \times (100 \div q)$; Rs. 400
6. 26·5 ft. **7.** 504 sq. yds. **8.** 285 sq. in.
9. 3 mm. **10.** 585,426

1915

1. (i) 7s. 6d. (ii) 8s. 1d. (iii) 42 p.c.
2. 18s. 3d. **3.** 3lb. nearly.
4. $T=\frac{1}{4}(3g+w+2p+4)$; 320.
5. $a=b(f-e)$; $c=d\,(b+e) : e=2$; f 10; 851 tons nearly.
9. Rs. 5-10; Rs. 3-12 **10.** Rs. 23283 **12.** 88 lbs.

1916

1. (1) −12 p.c. − 17 p.c. (2) + 11 p.c.; + 14 p.c. (3) −67 p.c.; −75 p.c. (4) −26 p.c. −27 p.c. (5) +2 p.c. +1·5 p.c. **2.** Rs. 9-4-6. **4.** 8. **5.** 17%,4 as
7. 1·64 in. **9.** $\frac{1}{6}(p+q+r) \times (4d+a), -(ap+bq+cr)$ as.; $d=20$, **10.** $x=6\frac{6}{7}$; $y=-\frac{4}{7}$,
12, $H : E :: 9 : 8$,

1917

1. 77 **2.** Rs· 61,100 Rs. 52,975-10-8, 13.3 p.c.
3. Rs. 525 **4.** Rs. 4472-14 as.; 6·4 p.c.
5. 205 ft. nearly. **8.** $x=a-7/2$.
9. Rs. 70; Rs. 130 **10.** 5 cm.

1918

1. Rs. 3-13-3; 16·7 p. c. **2.** Gain = Rs. 200
3. 13−37; 12−37: 16−45; I & II at the 29th mile at 13−8; I & III at the 66th mile at 14—52
4. 1,800,000 sq. mls.; 1 in. = 120 mls.
5. 4 p. c.; 4·8 p. c.; 5·8 p. c. **6.** Rs. 1232
7. 19·3 sq. cm. **8.** $(mx+ny) \div (x+y)$; 36·4
9. 29 miles **10.** (2) $\frac{1}{4}$ **11.** 30 miles **12.** 17 in.

1919

1. 38·6 ; C. (highest) 41·4 ; D (lowest) 34·5
2. Rs. 1600 ; 32·5 p. c. 3. 12·7 acres
4. 1. A reaches Q at 2-30 P.M. ; *B* at 1-5 P.M. ; 2. At 37½ miles from *P* at 11-15 A.M. ; 3. 12½ miles
5. Rs. 112 6. 25·8 sq. in. 7. 2 ft. 8 in.
8. 24 men and 20 boys 9. 1. 7·2 in. 2. 18 men
10. Cone ; 14 in. 11. $(am+bn)(100+c) \div 100(m+n)$; Re. 1-9
12. 2,964·5 sq. ft.

1919—Re-Ex.

1. A 57 ; B 37 ; A 1st. B. 67th 2. 16 lbs.
3. 13 yds. 4. 171·5 cub. in., 128
5. To get books from London by Rs. 42-8
6. 30 s. ; 15 s. ; 10 s. 8. Rs. 583-5-4
10. Gain 20 p. c. 11. 881¼ yds.
12. (1) $60/m-60/n$ (2) $\frac{3mn}{n-m}$ min. (3) 202 min.

1920

1. (1) 66·9 p. c. (2) Rs. 1,265,368
2. 11,619 cub. yds. 7½ min. 3. 175 ft. 4. Rs. 115-8
5. Rs. 240 and Rs. 360
9. *mnpq* 37½ (37 men and 1 boy) 10. 3 in.
11. 3000. c. cm. 12. 6·8 p. c. ; £ 2,516-16 s.

1921

1. 6,076 ft.
2. Of the 3 measurements, at least *one* should be that of a side ; $a=2{\cdot}1''$, $b=1{\cdot}5''$, $c=1{\cdot}9''$, $A=79°$, $C=60°$ and $B=41°$ 3. 14·96 sq. in.
4. (1) 3·9 p. c. (2) 7·7 p. c. (3) 8 as. 5. Rs. 45-4-10
6. 75 p. c. 7. 34·7 8. 14½ days
9. 12,667 sq. ft. 10. Rs. $a(r+1)-rs$; Re. 1
11. BA : 1 : : 8 : 13 ; 294

1922

1. (1) Rs. 17040, Rs. 24538. (2) 7·1%. **2.** 250 yds.

3. 1. (i) 4 cms. = 1·6 inches. (ii) 10 cms. = 3·9 −,, −
2. (iii) 2·8″ = 7·1 cms. (iv) 4·5″ = 11·4 cms.

4. The common point is (24,30.) (*i.e.*,) At the end of 24th performance and the amount spent is Rs. 30 by each.
From the 25th. performance the second performance is advantageous.

5. (277895 − 182320) = Rs. 95575.

6. length 23″ } nearly.
Breadth 14″ }

7. The quantity of alloy = 91 oz. **8.** The gain per cent. 40%. **9.** Rs. 72766.

10. 34·40 tons.

11. The angle of Sector representing;
Asia (17 m) = $17 \times 7\cdot^{\circ}2 = 122\cdot^{\circ}4$;
Europe (3·8m) = $3\cdot8 + 7\cdot^{\circ}2 = 27\cdot^{\circ}36$;
Africa (11·4m) = $11\cdot4 + 7\cdot2^{\circ} = 82\cdot08^{\circ}$;
Australia (3 m) = $3 \times 7\cdot2^{\circ} = 21\cdot6^{\circ}$;
N. America (8 m) = $8 + 7\cdot2^{\circ} = 57\cdot6^{\circ}$;
S. America (8·8 m) = $6\cdot8 \times 7\cdot2^{\circ} = 48\cdot96^{\circ}$;
Total $= 360^{\circ}$.

12. Substituting the values weget,

$$CD = \sqrt{4 \times 2\cdot25 \times 1\cdot69} = 3\cdot9 \text{ in.}$$

1923

1. (1) 8047462; 8189960 (2) 3·6 (3) 52·5

2. (1) 15,574 gms. (2) 4·52, 35, 32

3. 17·8 p. c. **4.** 4a. 3p. **5.** Rs. 192. **6.** 26

8. $(v^2 - u^2)/v$, m. p. h.; 59·6 *m. p. h.* **9.** 13 ft. 4 in.

10. 46·6 and 41·6 ft. **11.** (*a*) 1 : 4. (*b*) $\frac{5b^2l}{4}$; 25,000

12. 21·3″; 1810·3 c. in.; 655 sq. in.

1924

1. (1) 1798, 2047, 2324, 1901, 1722, 1901, 10379, 667, 647. 11693. (5) 7·3, 5·6, 3·3, 5·7;

2. 998·8 oz. Rs. 7-5 as.
3. Rs. 2000 : 13 of wine and 19 of water
4. Rs. 41-8-0 ; Rs. 3-7-4 **5.** $54\frac{6}{11}$ p. c. **6.** 98
8. 28 yds. **10.** $a=0·3$, $b=0·8$, $c=2·125$
11. 120 sq. ft. ; 7920000 gallons
12. $12\frac{5}{6}$ c. ft. : 44 sq. ft. ; 10·6 cub. ft. ; 17 p. c.

1925

1. (1) +2·7, +2·2, −1·4, (2) +0·88
2. Rs. 15-12 as., Rs. 28-14 as., Rs. 20-4 as.
3. £ 28-16-0 **4.** 40 yds. **5.** Rs. 958-13-0
6. 5·6 miles **7.** £ 24-13-4 **8.** 40 cms. nearly
9. 53° **10.** 2 ft. below the surface ; 30°
11. 135 and 30 **12.** 4·9 acres nearly
13. 2·5 gallons. Rs. 0-9-11 ps.

1926

Part A

1. (1) 6506·8 (2) United Kingdon −1·9% ; Belgium − 12·1% ; Germany +223·8%
2. 18 miles per hr. **3.** 999·9 ounces
4. (1) Rs. $5\frac{1}{4}$; (2) 160 lbs. (3) 40 lbs.
5. AC = 650 links, and CDA is a right angle ; area = 1·76 acres
6. 745·7 c. cms.

Part B

1. 7% ; A received £ 1050 ; B received £ 872-10 s. ; sum left over = £ 52-10 s.
2. Rs. 6-1-$2\frac{2}{5}$ ps.
3. £ 150 value of estate ; £ 100 and £ 200—Debts
4. $6\frac{2}{3}$ minutes

5. First election A 3420, B 2880; Second election A 3780, B 2970
6. P. W. must be calculated on 1980 due two years hence at $5\frac{1}{2}\%$ C.I. £ 1778-19 s.

1927 A

1. 7·9 %
2. 33·1%; $z=\dfrac{ax-by}{a-b}$
3. Rs. 1000
4. Regular members 140, Associates 60
5. B will overtake A at 8 A.M., 12th mile

1927 B

7. A Re. 1-6, B Re. 1-10
8. 1 : 2
9. 4 hrs. 37 mins. 12 secs.
10. 60 miles by rail and 90 miles by river
11. 3762 yds.
12. 24ft. 18ft.

1928

1. 12·5
2. $3a+4c-10=e(b+d)$
3. Rs. 1,500
4. 68 miles
5. 5·8 sq. in.
6. Rs. 250
7. Rs. 242
8. 31·8
9. 16 ft.
10. 10-30 A M., 6-30 A.M.,

1929

1. (*a*) 51 yards (*b*) 2,160. marks
2. (*a*) 280
(*b*) Rs. $\frac{7}{8}p(x+y)-mx-ny$; Rs. 9
3. 50 men
4. Rs. 46,000
5. 6·24 sq. in.
6. 5%; Rs. 250
7. Rs. 334-11-0
8. Loss 1%
9. Rs. 110
10. 21 ft.
11. 7−36 P. M., 3 and 5 P.M. 19 miles from Q
12. 352 ft.

1930

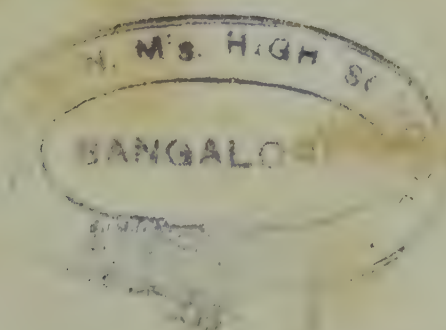
1. 25% 2. 40 days 3. $=2d\ (3b+3l+2d)$; $b=15$
4. 24·1% 5. Rs. 325
6. ·8 in., 1·35 in.; 1·9 sq. in. 7. 5 ft. nearly
8. 110 and 230 9. 18·26 sq. in.; 15·15 in.
10. 9−5 A. M. $4\frac{1}{2}$ miles from the station

1931

1. 17, 500 2. $c\,(b-a)=ab$; $c=60$
3. 5·1 sq. in. 4. Rs. 898−10 5. Rs. 3,040
6. Rs. 305, Rs. 310 and Rs. 330 7. 741 *c. cm.*
8. Rs. 1−4; 12 *a.*
9. 24·5 miles $(24\ \frac{6}{11})$ from A; 1 hr. 40 min. $(1\frac{7}{11}$ hours) after the first train started; 17 miles from B
10. (*a*) 12·6 in; 13 in. (*b*) 10·5 ft.

1932

1. 33·1 and 13·9 2. Rs. 787−8 as. 3. 6 days
4. 10% 5. Av. $= \dfrac{b\,(2c-b)}{c}$; $9\frac{3}{4}$; m. p. h.
6. A; £ 3122−9−2 B; £ 2081−12−10.
   C; £ 2445−18 7. House. Rs. 6,500
   Garden. Rs. 2,500 8. Sum lent = Rs. 5,202
9. 270000 acres 10. 31·7 lbs.
11. B should give A, 50 yds. B runs 80 and C. $53\frac{1}{3}$



R.B.A.N.M

Accession N

U.D.C. No

Date;

R.B.A.N.M'S H.S (M) LIBRARY
B'lore-42

Accession No ; 206

U.D.C. No : 512.1513/SUB

Date; 13-1-81

3 AUG 1987

14 AUG 1987
12 NOV 1987

30/7/90

3/7/91

R. B. A. N. M'S
High School (Main) Library

BOOK CARD

Author ...SUBRAMANIAM (P.R).

Title...Modern Elementary mate.
...maths

Account No. ...206...

No ...512+513 (SUB) N32

Borrower	Card No.	Due Date
	3	AUG 1987
	4	AUG 1987
		NOV. 1987
		1987

Date:

U.D.C. No.

Accession

R.B.A.N.M.